PERSISTENT OCCIPITO-POSTERIOR POSITIONS.

THESIS

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I N D E X

List of Illustrations.

PART ONE.

THE ETIOLOGY OF PERSISTENT OCCIPITO-POSTERIOR POSITIONS

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In I742 Sir Fielding Ould mentioned the high transverse position of the occiput at the beginning of labour - an observation which is easily ratified by abdominal palpation of parturients in early labour. Almost two centuries later Caldwell, Moloy and D'Esopo[1] concluded from their radiological studies on the mechanism of labour, that the transverse position of engagement is the usual one. Radiological study also confirms a view long held by many obstetricians that before engagement the head normally rests on the pelvic brim with the sagittal suture nearer the pubes than the promontory and with the posterior parietal bone presenting. This attitude however, is unstable, for under normal conditions of pelvis and foetal head this posterior asynclitism gradually disappears and the occipito-frontal diameter of the child's head, by reason of flexion comes to be parallel or approximately parallel to the plane of the brim. As the head traverses the inlet synclitism becomes gradually established. After the occiput has passed the inlet it rotates either to the front - and this applies to the vast majority of cases (70 per cent of I5,000 cases investigated by one observer) or it may rotate to the back. An occipito-posterior position will result under the following circumstances:-

a) If the occiput rotates to the hollow of the sacrum;

b) If the head enters the pelvis in an oblique diameter with the occiput behind;

c) In rare instances the head enters the pelvis with the occiput directly behind and remains there throughout labour. This is the uncommon primary occipito-sacral or dorsi-sacral position.

Ordinarily when we speak of right occipito-posterior position it is implied that the sagittal suture occupies the right oblique diameter of the pelvis. This is not completely true in all cases since the sagittal suture may occupy a number of intervening oblique axes, so that some posteriors engage in the implied oblique diameter while others engage with the occiput slightly posterior to true transverse. The practical significance of these variations in position is related to the mechanism of descent.

It is necessary at this stage to define the term "persistent occipito-posterior position." Certain types of cases may be regarded as falling in this category. The cases included in my series can be classified under

four headings.

a) spontaneous delivery with the occiput occupying any position posterior to true transverse. Most commonly the occiput in this type of case lies directly posterior or much less commonly in the left or right posterior position.

b) Cases in which it has been necessary to rotate the occiput to an anterior position, either manually or with the forceps, before delivery was effected.

c) Cases which were delivered with the occiput posterior either because manual or forceps rotation was unnecessary, undesirable or impossible.

d) All cases in which the occiput occupied a posterior position at caesarean section.

e) Cases in which internal version was performed in the management of a posterior position of the occiput.

Further comment on this last group of cases is necessary. A caesarean section may be performed for, say fulminating pre-eclamptic toxaemia in a parturient who has only been in labour for a short time. If at operation the position of the occiput is posterior, the case is recorded as a persistent occipito-posterior position. This is not strictly correct. Had circumstances been different and permissible of a longer labour, the occiput might have rotated anteriorly. But since it is neither possible nor practicable to hypothetically classify this group of cases into those which would have rotated and those which would have 'persisted', they are all included under the terms persistent occipito-posterior position, the most of which can be said is that it is only to a degree terminologically correct.

There are two facets of this brief discussion which may be mentioned here and which will be the subject of a more detailed later discussion under different headings. The first concerns the variation in incidence inevitably engendered by the individual obstetrician's time and mode of intervention in these cases. The second refers to conservative intervention before full dilatation of the cervix. If manual (or sometimes only digital) rotation is successfully attempted per vaginam before full dilatation of the cervix, should the case be classified as a persistent occipito-posterior?

There are only a very few people who practice this so that whether or not this group of cases is included, does not appreciably alter the overall incidence in any series. As a rule the occiput rotates anteriorly late in the second stage. Before full dilatation it is usually at a level at which rotation is not expected so that little can be achieved by this practice unless the head is low and the cervix almost fully dilated. In the multiparous parturient delivery often takes place before full dilatation or effacement - the term 'fully dilated' is used here with its usual obstetrical significance. In this type of case manual rotation of the lagging occiput sometimes expedites the course of labour whereas previously it was slow and difficult. It is submitted that this type of case should be included in our statistics. (de Villiers[89])

INCIDENCE

A study of the literature shows that the incidence of persistent occipito-posterior positions in British hospitals is uniformly under three per cent. The following figures are quoted by English authors.

Dugald Baird[2]	2.6 per cent
I. Donald[3]	2.0 per cent
Gibberd[4]	2.0 per cent
Stern & Burnette[5]	2.36 per cent
Mac Lennan, Wrigley and Percival[6]	1 - 2 per cent

Bethel Solomons reported a rate of 1 per cent in some 15,000 cases delivered at the Rotunda hospital during his mastership. In A.A. Gemell's report for the Liverpool Maternity hospital for 1929, the rate was 1 per cent.

The incidence according to the German literature varies between 0.1 and 1 per cent. A. Fink[7] found the rate to be 0.1 per cent in a series of 49,746 consecutive deliveries.

It is amongst the American obstetricians that one sees the greatest variations in incidence, the rate

I.

RACE	TOT. DEL.	POPS	INCIDENCE	PRIMPS.	N.B.	ROP.	LOP.
COLOURED	8451	205	2.42	38%	44%	58%	42%
BANTU	3549	183	5.2	42%	47%	68%	32%
TOTAL	12,000	388	3.233	39%	44.9	60.8	38.1

Pops = Persistent Occipito-posterior positions.

N.B. = Non-booked admissions.

2.

RACE	POPS	SFTP	FORCEPS	C.S.	S.Bs	N.N.Ds	Int. V	3rd D.T
COLOURED	205	131 63.9%	57 27.8%	17 8.2%	24	8	1	0
BANTU	183	79 43.17%	69 37.7%	35 19.1%	13	14	0	1
TOTAL	388	210	126	52	37	22 (5.6%)	1	1

C.S. = Caesarean section

SFTP = Spontaneous face to pubic delivery

S.Bs = Stillbirths

N.N.Ds = Neonatal deaths

Int.V. = Internal version

3rd D.T.= Third degree tears.

3.

RACE	Forceps	Manual Rot	Man. Rot.Not attempted	Rot.Failed	K.R.	Rot.onl
COLOURED	57	38	4	I3	2	0
BANTU	69	33	I8	I6	I	I
TOTAL	I26	7I	22	29	3	I

Rot. = Rotation

Man. = Manual

K.R. = Rotation with Kiellands forceps.

4.

No. of Cases Studied.	TYPE OF CASE.	Weight.
50	I. Spontaneous Face-to-pubes	7lb. 5ozs
I00	2. Spontaneous- Occipito-anterior.	6.4
48	3. P.O.P- Forceps.	7.I3½
32	4. P.O.P- Forceps- stillbirth, neonatal death	8.4¼
I7	5. P.O.P. Caesarean section.	8.5

varying from 2 per cent to 7 per cent (Cosgrove)[8] and even over 10 per cent (A.H. Bill.) This abnormally high computation and variation of the incidence is related more directly to the individual obstetrician's management of his cases rather than abnormalities peculiar to his particular cases. Bill[2] is the epitome of radicalism and his high incidence of persistent occipito-posterior positions is understandable when one realises that he is constrained to do internal version if the head remains unengaged at the beginning of the second stage - a mode of intervention which happens in 63.4 per cent of his occipito-posterior positions. Moreover, he allows only one hour in the second stage for spontaneous long internal rotation to take place, and accepts a forceps rate of 34.4 per cent.

Thus the accoucheur who advocates interference shortly after full dilatation instead of allowing a suitable trial period for spontaneous rotation to take place, will have a higher incidence than his more patient and less radical colleague. Yet we must recognise that differences in management are not the only factors responsible for variations in incidence, for, as will be shown, in a multiracial community such as Cape Town, the racial factor is of some importance.

In the Cape Town Teaching Hospitals the incidence of persistent occipito-posterior positions has been recorded as being above 3 per cent in annual reports. In 12,000 consecutive deliveries at the New Somerset and St. Monica's hospitals over the period 1949 to 1954, the rate was 3.233 ± 0.5035 per cent. The striking revelation of this table is the Bantu rate of 5.2 ± 0.3742 per cent which is more than double the incidence in the Coloured group(2.4 ± 0.1668 per cent.) The standard error of the difference is 0.4096 per cent so that the percentage difference for the series is 2.8 ± 0.4096 per cent which is 7 times the standard error. The difference in incidence in the two racial groups is therefore statistically significant.

On further analysis of the persistent occipito-posterior positions in my series, certain differences between Coloured and Bantu patients deserve further mention. The method of analysis here follows the principles of statistics; comparison between the two racial groups is based on statistical significance.

Of 205 cases 63.9 ± 3.355 per cent delivered spontaneously in the face-to-pubes position in the Coloured group. The corresponding figure for Bantu parturients is 43.4 ±3.664 per cent. The percentage diff-

erence for this mode of delivery is 20.5 ± 2.164 which is 9.473 times the standard error. There is therefore a highly significant difference between the two groups.

Differences of similar statistical significance can be demonstrated in respect of other modes of delivery. Thus the forceps rate was 27.8 ± 3.564 per cent for Coloured and 37.8 ± 584 per cent for Bantu patients; the standard error of the difference is 2.486 so that the percentage difference of 10 ± 2.486 is 4.022 times the standard error for the series.

The figures for the caesarean section rates show a similar disparity. The figure for Coloured parturients is 8.2 ± 1.917 per cent and that for the Bantu 19.1 ± 2.899; the percentage difference of 10.9 ± 2.194 is 4.968 times the standard error.

These computations demonstrate differences of statistical significance between the two racial groups. Yet these differences are of even greater magnitude than these statistics indicate. To visualize them in their true perspective, we must view these figures against the background of Bantu obstetrics in general.

Most South African obstetricians will attest to the excellence of the Bantu as a parturient. Their

superiority is best demonstrated by reference to certain computations by South African writers. Heyns,[10] and Heyns and Shippel,[11] have written about the Bantu as a parturient. Their study is based on a series of 1,433 Bantu antenatal patients seen over a period of five years. The control series was constituted by 5,059 European antenatal patients. They showed a "highly significant statistical difference for operative delivery" in the two racial groups - the "European requiring assistance more often than the Bantu." The overall percentage difference for operative delivery was 4.682 $\pm$ 0.37 which was 12.77 times the standard error for their series - despite the fact that the number of primiparae in the European group was 6 per cent (4.04 times its standard error) higher than the Bantu. They state that forceps was only once applied in 1,069 Bantu deliveries and quote a percentage difference which is 7.22 times the standard error for their series.

Heyns also states that the marked ability of the Bantu women to deliver herself without assistance, is still more remarkable when one bears in mind the fact that the average Bantu female pelvis is slightly smaller than that of European women - the largest pelvis in Heyns' series of 67 dry pelves being equal to Ince and Young's

average; also, the Bantu head at birth is equal to that of white races. All things being equal, the Bantu parturient should have a lower incidence of spontaneous birth than the European. Yet the reverse obtains.

Here then is a paradox: the finest group of parturients in South Africa not only has a higher incidence of persistent occipito-posterior positions but also a much higher rate for operative delivery. The figures for operative delivery in the persistent occipito-posterior series are the very antithesis of those for anterior positions. The problem is not only a more common one amongst the Bantu but a more difficult one to boot. This suggests that there is a fundamental factor responsible both for the higher incidence and the poorer outcome for natural delivery. This observation prompted the investigation into cranio-pelvic relationships in Bantu parturients recorded further on in this work.

ETIOLOGY.

In the discussion which is to follow repeated references will be made to the Bantu and Coloured peoples; also anatomical comparisons will be made between these two

racial groups, and differences of considerable importance in regard to certain etiological concepts will be demonstrated. It is necessary therefore at this juncture to define these two terms; the detailed nature of the material selected for the pelvic and craniometrical studies, is recorded later under the corresponding headings. The anthropology of the Cape Coloured is as follows. They are of mixed-stock being descendant from the Malayan convicts imported into the Cape Colony, the Hottentots and the Bushman. The other branch of their anthropological tree is the British, Dutch and early French settlers. They have also received infusions from sailors of many nationalities in their earlier history. The point I want to stress is that in the short history of this people, they have not been contributed to by the Bantu in any recordable degree. This realisation is necessary when conducting comparative craniometrical and pelvimetrical studies.

In assessing the various etiological factors responsible for persistent occipito-posterior positions, an explanation must be sought to account for the variation in incidence in the two racial groups. Reasoning at first along purely theoretical lines, the following possibilities must be considered :-

a) That the incidence of occipito-

posterior positions at the onset of labour is greater in the Bantu and, while the percentage of cases undergoing spontaneous long internal rotation is the same as in the Coloured, or somewhat less, it is of such an order that the overall ratio of persistent occipito-posterior positions per hundred deliveries is greater.

b) That the incidence of occipito-posterior positions at the onset of labour is the same in the two groups but a greater proportion fail to rotate anteriorly in the Bantu.

c) A combination of factors a) and b) i.e. that the Bantu has both a greater number of posterior positions at the onset of labour as well as a higher rate of failure for spontaneous rotation.

A numerical study was therefore conducted to

determine the relationship between these factors and the frequency of persistent occipito-posterior positions. The statistics and computations in table ~~III~~ 5 were obtained from the files of patients delivered at the New Somerset and St. Monica's hospitals over a period of several years. The designation of a case as an occipito-posterior in this series applies only where the head is engaged. The decision as to the exact position of the head was made from a combination of abdominal and vaginal examinations.

TABLE 5.

NO. OF CASES	BANTU	COLOURED
Total Investigated	1899	2606
No. of cases with occiput posterior at onset of labour	301 (16.16%)	272 (10.42%)
No. of P.O.P'S	98 (5.159%)	63 (2.301 %)
Percentage Undergoing spontaneous rotation	67.66	76.83

Applying the conventional formula for differences according to the principles of statistics the standard error for comparison in the spontaneous rotation group is found to be

$$\sqrt{\frac{67.66 \times 32.34}{1899} + \frac{76.83 \times 23.17}{2606}} = 1.358$$

The percentage difference for this group is therefore 9.17 ± 1.358 which is 6.753 times the standard error and therefore of statistical significance. Similarly the incidence of occipito-posterior positions at the onset of labour is 5.74 ± 0.9196 per cent higher in Bantu parturients; this is 6.241 times the standard error for the difference.

From this brief numerical study it will be seen that the high Bantu persistent occipito-posterior rate is accounted for by the greater number of occipito-posterior positions as well as the greater percentage which fail to rotate spontaneously and completely.

A different series of cases was selected, namely, those in which the head was not engaged and in which, therefore, the pelvic shape could exert no in-

fluence on the foetal position. Expressed in a different way - the foetal position in this series of cases was entirely dependent on uterine factors. This investigation was carried out because of the possible role uterine factors may play in determining persistence of the occiput in the posterior position. The results are recorded in table VI.

From this table it is seen that even when pelvic influences are excluded the incidence of occipito-posterior positions is greater in the Bantu.

The statistics in tables V and VI were compiled from records of patients delivered at the Somerset hospital. Those in table V were personally ex - - amined . The series in table VI extends over a longer period; less than 50 per cent were personally examined (i.e. cases seen between February 1955 and June 1957) for the rest reliance had to be placed only on the records. All patients were in the last two weeks of gestation.

Of the patients in table III 812 Bantu (44.77%) and 1017 Coloured (39.01%) were in early labour at the time that the position of the head was recorded. In no instance was the degree of cervical dilatation beyond

'two fingers.' Parturients who were further advanced in labour than this, were not included in the series. It may be assumed therefore, with reasonable certainty, that the possibility of having included cases in this investigation which started labour as a posterior position and which had rotated by the time the examination in hospital was made, is remote.

TABLE 6.

NO. OF CASES	BANTU	COLOURED
Total Investigated	3225	5430
No. of occipito - posteriors	612	597
Percentage of Total	18.98	11

It is of considerable interest to note here similar investigations which have been conducted by different authors. Wrigley, Mac Lennan and Percival[12] state that both uncertain and widely varied figures have been

accumulated from the results of abdominal and vaginal examination at various phases of pregnancy and labour, whereas all sets of figures obtained by radiography show close agreement. Steele and Javert[15] in 1942 conducted a radiographic study on 1040 patients "at or near term or in labour up to the end of the first stage." They divided their patients into two groups.

i) 763 Cases 'with the head in or above the brim.'

ii) 277 Cases with the head 'in the pelvis above or just below the level of the ischial spines.'

The percentage incidence of the various positions is shown in the following table.

TABLE VII.

	LOT	ROT	LOA	ROA	O.A.	ROP	LOP	OP
GROUP I	40	24	13	10	2	7	3	1
GROUP II	34	29	12	6	3	12	3	2

LOT LEFT OCCIPITO TRANSVERSE
ROT RIGHT " "
LOA. LEFT. " ANTERIOR.
ROA. RIGHT. " "

OA. OCCIPITO ANTERIOR
ROP RIGHT OCCIPITO POSTERIOR
LOP LEFT. " POSTERIOR.
OP OCCIPITO POSTERIOR

According to the findings of these workers the incidence of occipito-posterior positions in group I is 11 per cent and the incidence in group II, 17 per cent. This difference may at first sight appear of some importance. However, on statistical analysis the percentage difference is found to be only 2.395 times the standard error of 2.504 for the series. It is hardly significant.

A second and more important observation to be made from this table is the rearrangement in the relative numbers of right and left positions in the two groups; this consists mainly in a relative fall in the number of left occipito-posterior positions as the head enters the pelvis. This disparity is not fortuitous; it is dependent on one of the fundamental factors in the causation of persistent occipito-posterior positions, namely, the angle subtended by the plane of cranial contact and the projected line of force from fundus uteri, along the foetal spine to this plane, becomes more obtuse when the foetus presents in the right occipito-posterior position. In Steele and Javerts series the ratio of left to right positions is 3:7 in group I but 3:12 in group II. Stated differently - the right occipito-posterior position is twice as common as the left at the inlet but four times more common in the mid-pelvis. It appears difficult to

avoid the conclusion that a number of cases of the more favourable left position had rotated anteriorly at the time these workers conducted their examinations. The issue which arises from this assertion is one for further discussion namely, the percentage of cases which rotate early in labour or in the mid-pelvis.

Mac Lennan conducted a similar radiological study on I,000 patients "at or about the 36th week of gestation." He found the incidence of posterior positions at the brim to be 15 per cent. This figure is between that obtained for Bantu and Coloured patients in my investigations. Whether the figures are strictly comparable is difficult to judge. The nearer the patient is to term, the closer is the relationship between bony pelvis and foetal head. At the 36th week this relationship is almost non-existent or remote. The Bantu and Coloured figures, in table VI were compiled only from patients at or beyond the 38th week of gestation, that is, at a time when pelvic influences as determinants of the position of the head, are of increasing significance. With this reasoning therefore, it is better to leave the analysis and comparisons and to approach the question of the etiology of persistent occipito-posterior positions in the following two ways :-

1) Factors influencing the foetal position during pregnancy and the possible role these factors play in determining the position of the passenger in labour.

2) Factors responsible for failure of spontaneous anterior rotation of the occiput.

FACTORS INFLUENCING THE POSITION OF THE FOETUS IN PREGNANCY AND LABOUR.

Flexion is the normal attitude for mammals during pregnancy. As term approaches it becomes flexion or extension according to the species. The foetus can best achieve its normal attitude if it lies in a dorsipubic position where the rounded flexed back is allowed to bulge out the anterior abdominal wall. These are the factors which influence the foetal position during pregnancy. In those cases in which the posterior uterine wall is longer and more convex than the anterior (as in the grand multipara with a pendulous abdomen and a well anteflexed uterus) a posterior position of the back will be favoured - especially if the placenta lies anteriorly, a position which it occupies in nearly 40 per cent of cases.

It has already been stated that late formation of the lower uterine segment is responsible for non-engagement of the head in the last two weeks of gestation in the Bantu. This immediately invokes the thought that a uterine factor may be responsible for the higher percentage of cases in which the back is posterior in this group of people in the pre-term patient; also, the same factor may possibly be responsible for the persis-

tence of the occiput in the posterior position in certain cases.

Nearly every smooth muscle organ in the body shows variations in shape, these variations being related to general body-build. Thus the tall slightly built individual has a long J-shaped stomach, a long narrow heart, hypotonicity of the bowel musculature, and a transverse colon which dips far down into the abdomen, being suspended from the posterior abdominal wall by a long mesentery. The hypersthenic individual has his own physical peculiarities. It is common observation that amongst Bantu women the masculine types are frequently seen. Of heavy muscular development, these women have broad palms, wide shoulders, short broad feet, little or no waist and heavy limb musculature. The incidence of pelvic types showing a strong android tendency is higher in Bantu women than Europeans and American white women, as will be shown later; also it will be shown the extent to which the android pelvis is incriminated in the causation of persistent occipito-posterior positions. Here it is pertinent to quote Ian Donald's[14] words ".....there are some cases, usually muscular girls, in whom no adequate explanation presents itself (viz. to account for a high mobile head at term.) It is as though

the whole uterus including the lower segment, tended to ride high. In such cases disproportion is hard to exclude, and only the events of labour will provide evidence in retrospect." He also states that the bony structure of these women tend to the android type and that the dimensions of the vagina are skimpy, noticeably in the vault and the cervix is small. Labour starts with the head high and in the majority of cases occipito-posterior in position. Donald's description is aptly applicable to many of our Bantu parturients. The association of a high head, presenting in the occipito-posterior position, and a skimpy, tight vagina in a woman of android habitus, is one which we see more commonly in the Bantu than in any other group of parturients in the Somerset hospital obstetrical unit, where Bantu, Coloureds, Cape Malays and much smaller number of Indians are delivered.

The uterus and the vagina have a common origin from the united distal portions of the lower Müllerian ducts, and it is conceivable that this narrow type of vagina may be associated with a more or less constant variant of uterine shape. The close anatomical, and, in the case I am about to quote, functional kinship between cervix and vagina, is illustrated in the parturient who

had an annular septum at the junction of the upper and middle thirds of the vagina. The patient was a 26 year old secundipara who had a previous caesarean section performed because of the vaginal abnormality. With her second pregnancy she was allowed to go into labour at term. Earlier assessment of the pelvis both clinically and radiologically had shown it to be of normal dimensions. The foetus presented by the vertex in the right occipito-posterior position. As labour progressed the vaginal septum dilated pari passu with the cervix - yet there was no pressure of the presenting part on the septum to bring about this dilatation. Forceps was applied fifteen minutes after the cervix was fully dilated. It was necessary to incise the septum which at that stage presented as a firm annular band like a length of string encircling the vagina. This patient, incidentally, had a normal unassisted delivery with her third labour.

Perhaps there is a variation in uterine shape which is related to general body-build, but whether the masculine type has a uterus whose configuration favours a posterior position of the back, is in the realm of conjecture rather than fact. To prove or disprove this possibility is a matter of considerable difficulty. The study of uterine shape would mean the use of amniography

which at its present state of development is quite unsatisfactory. Direct observation on the uterus at caesarean section does not lend itself to satisfactory and accurate study and is therefore not feasible. Hysterography records antedating pregnancy may be of little value. Even this method of approach to the problem has many and great disadvantages, chief amongst which is the inevitable distortion of the uterus due to spasm though this is seen mainly in antero-posterior views of the organ rather than in lateral view pictures. Hysterograms done under general anaesthesia or the action of short acting hypnotics may be of value in the study of uterine shape. Smooth muscle tone and spasm are more directly related to central nervous activity, (hypothalamic impulses) than local reflexes. The same central influences have been invoked as etiological agents in prolonged pregnancy.

No definite statement can be made on the inherent variations in uterine shape and the relationship between variants and corresponding bodily types. So for the present the possible role of a uterine factor being responsible for the higher percentage of cases of occipito-posterior positions in the Bantu must remain as conjecture.

The nearer the patient approaches term, the thinner becomes the lower segment and the more intimate becomes the relationship, till now remote, between bony pelvis and foetal head. As one would naturally suppose there is quite a definite tendency for the head to enter the pelvis with the sagittal diameter in the widest diameter of the pelvis. As shown by the radiological studies of Caldwell and Moloy, this is the transverse diameter of the pelvis in the majority of cases. If however, the antero-posterior dimensions of the pelvis exceed the transverse, engagement will tend to take place with the sagittal suture in the antero-posterior diameter. If in addition the fore-pelvis is narrow and the hind-pelvis adequate engagement will be as an occipito-posterior position. This statement presupposes a similarity in magnitude between the foetal head and the pelvic dimensions. If the foetus be small and the pelvis roomy, no adaptation is necessary and the head may engage in any position. The relationship between the pelvic type and the position of engagement is recorded in table IO . The higher percentage of engagement as posteriors in android and anthropoid forms is clear.

When labour starts the uterus will tend to

rotate the foetus to the best position if the PELVIC ARCHITECTURE ALLOWS, just as it rotates the quadrupeds round from the dorsipubic to the dorsisacral position. Should this mechanism of long internal rotation fail, a persistent occipito-posterior position will result.

FACTORS RESPONSIBLE FOR THE FAILURE OF SPONTANEOUS ANTERIOR ROTATION OF THE OCCIPUT.

The factors responsible for rotation of the occiput in labour are not completely understood. Opinion still varies as to whether the factors responsible for the normal mechanism are entirely uterine in function or whether the lower part of the genital tract is alone concerned in the rotatory movements executed by the head in labour. While it is beyond the scope of this work to enter into a discussion of the various theories concerning the causes of rotation, many of which are of a controversial nature, certain views may be mentioned in so far as they help to clarify the failure of this mechanism in occipito-posterior positions.

Persistent occipito-posterior positions may be caused by a failure of the normal mechanism of labour or the presence of factors which render the mechanism impossible. It is proposed then to discuss labour in persistent occipito-posterior positions under the following headings :-

1. The normal mechanism of labour.
2. Failure of the mechanism of labour in occipito-posterior

positions.

3. Factors which render impossible the mechanism of long internal rotation.

THE MECHANISM OF LABOUR.

Rudolph and Ivy[15] stress the intrinsic action of the uterus as a rotator of the child's body. The shape of the uterus undoubtedly plays some role as suggested by Alshauzen (quoted by Paramore). Bumm accepting Alshauzen's explanation, introduces another factor substantiated by the stereoscopic studies of Caldwell, Moloy and D'Esopo.[17] Paramore quotes Bumm as follows : "It is the trunk which institutes the anterior rotation and imparts to the occiput the impulses which cause it to rotate in the same direction." Paramore[16] continues thus : "The rotation of the foetal trunk is determined by the forward projection of the maternal vertebrae column, this prevents the foetal back from rotating completely behind, and combined with the effects of the uterine contractions, causes it first to become lateral and finally anterior. In this way the foetal trunk carries the occiput with it."

Caldwell, Moloy and D'Esopo[17] believe that the

influences concerned with rotation discussed above may be greatly assisted by two factors which they observed consistently in the course of their stereoscopic investigations. The first is the angle of the foetal axis toward the inlet. The second concerns the inclination of the inlet to the maternal vertebral column. This obliquity is especially noticeable in anthropoid types in which posterior positions are prone to occur. They consider a third factor - a very obvious one - namely, that the pelvic brim is bounded anteriorly by the yielding abdominal wall and posteriorly by the fixed maternal hard parts. These three factors bring about a state of affairs in which a moving body is directed tangentially toward a plane that is inclined downward and a forward and a spiral movement takes place in the line of least resistance.

This explanation of these American workers is perhaps an over-simplification of a very complex mechanism. They have reduced the matter to one of simple mechanics. The initiation of the process of long internal rotation probably takes place in the manner they outline. It may occur at varying levels above the pelvic floor or the originial posterior position may persist particularly if some secondary factor in the pelvic architecture exists,

until the muscular pelvic gutter of the levatores ani, is reached. Again, the lower pelvic factors may prevent or assist in the rotation of the head, such as the shape of the lower bony architecture or the grip of the soft parts. For the present we are concerned with the assistance to rotation afforded by the lower pelvic factors.

The lower part of the genital tract from the lower uterine segment to the vaginal orifice may be looked upon as a potential elastic and resilient channel which will not be completely opened until the largest disengaging sectional plane of the foetal head is passing through its outlet. It is surrounded by a bony pelvic cavity throughout the greater part of its extent and its lower curve is supported by the terminal part of the sacrum and the muscles of the pelvic floor. The flexed foetal head may be likened to a solid slightly eccentric dome-shaped or semi-paraboloid body with a plastic vault and a rigid base joined by the flexible neck to the cylindrical trunk. Moulding and caput succedaneum formation usually increases the likeness to such a body and, in its normal attitude in the pelvic cavity of complete flexion and in the absence of any constraining forces, extension of the head is easier than

further flexion (Hunter.)[18.]

If such a body is driven through a proportionate cylinder of circular cross section which is partially straight in its upper reaches and partly curved in its lower, it will attempt to follow the straight and curves of the canal. Its apex will therefore follow the axis, the shortest transverse sectional planes will engage in the transverse sectional planes of the straight and "normal" (to the axis or radius of the hypothetical hollow ring of which the curved part of the channel would be a segment) sectional planes of the curved portion of the canal.

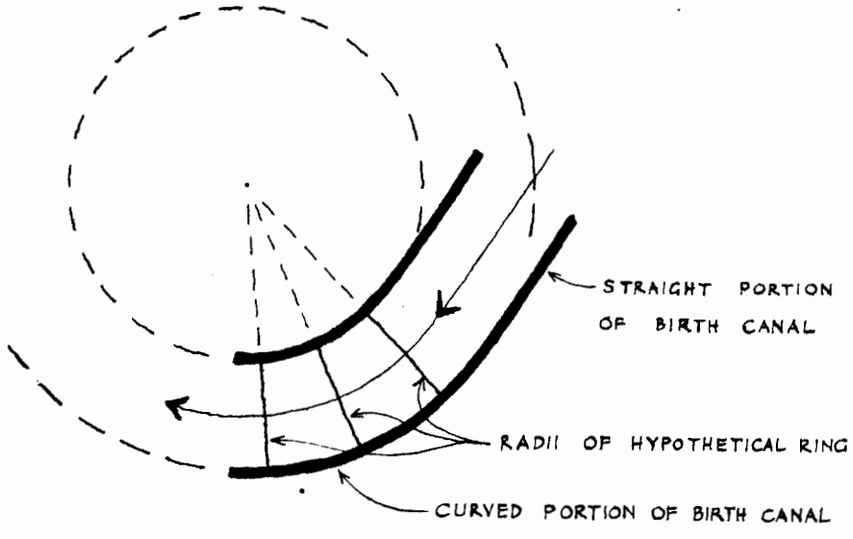

DIAGRAM SHOWING THE NORMAL SECTIONAL PLANES OF THE BIRTH CANAL

Any tendency of the apex to alter its course

in relationship to the central axis of the canal will be checked by the resilient walls which will deflect it back towards the centre of the passage where a state of equilibrium will be reached.

In the case of the foetal head, flexion and extension can occur in the sagittal plane with sub-occipito-bregmatic and mento-vertical diameters. By application of the wedge and lever principles, head flexion occurs until a state of balance is obtained with the highest point of the vertex in or near the centre of the canal. As the coronal plane with bi-parietal cummento-vertical diameters, is bilaterally symmetrical, lateral flexion to right or left is exceptional in the upper birth canal.

The walls of the birth canal behave like an isotropic elastic membrane with equal deformability in all directions. They offer greater resistance to the passage of the head through them when deformed irregularly by the engagement of the greater diameters due to decreased flexion than when stretched uniformly (Rydberg 19. 1935.) Under these conditions the attitude of flexion is effected and maintained, the smallest sectional planes are brought into the normal sectional planes of

the birth canal at the various levels of the girdle of contact, and the most favourable position for delivery is facilitated.

Erection of the uterus during uterine systole causes the foetus to be driven downwards and backwards through the pelvic brim and into the pelvic cavity where the presenting part tends to "hug" the sacrum and, in the lower curve of the birth canal, to expand the pelvic floor. (Caldwell, Moloy and D'Esopo 1935)

The greater the angle of drive the more likely is the presenting part to follow this favourable course. (Gold 1950.) The larger drive angles are assisted by the erect posture and hindered by the obstetric binder (William Hunter 1953.)[18.]

Extension results in the fitting of larger sectional planes into the canal; thus in the unmoulded head the occipito-frontal plane is 47 per cent and the mento-vertical coronal plane 80 per cent greater in area than the suboccipito-bregmatic coronal plane.[18.] The difference is even more pronounced when the head is moulded in its attitude of complete flexion. Full flexion minimizes resistance to descent by reducing the area of the plane of engagement of the head and, therefore, of the

degree of expansion of the birth canal necessary to accommodate it.

Rydberg (1935) has demonstrated the foetal head as an asymmetrical kidney-shaped body even in its attitude of complete flexion, with the greater part of its mass above the level of the mento-vertical caronal plane. If the head is driven vertically downwards against the sloping pelvic floor, with its greater prominence lying towards the rear as a direct occipito-posterior position the point of contact will be directed forwards and increased flexion will result. If the position of the head is made slightly eccentric to correspond with the right or left occipito-posterior positions, the point of contact will again be deflected forward but, in view of the eccentric position of the occiput this will result in rotation in the plane of contact to bring the occiput forward (Hart 1880.)

By a process of accommodation the concave posterior aspect of the foetal head and shoulders rotates forward until it is applied to the inner convex surface of the birth canal. It rotates as a result of the eccentric pressure of the resilient walls of the tube until its curve corresponds with the curve of the canal when the rotational forces are equalised. The

continual elastic resistance offered by the soft tissues ensures that it is closely embraced by the walls of the canal and so, throughout its descent, its lower pole is kept in firm contact with the curving slope of the inner concavity of the canal and is constantly being driven towards its centre (Young 1913.) Thus in the absence of any contrary force, the dome of the flexed head leads the presenting part through the centre of the birth canal as the head descends during labour and rotation takes place in the plane of contact to allow it to negotiate the lower curve of the canal.

Moir[20] (1938) has shown that lateral flexion of the already flexed foetal head is more difficult than extension and further flexion more difficult than lateral flexion owing to the resistance of the opposing muscle groups. The foetal head on passing through the birth canal therefore tends to rotate until the side of easy flexibility, that is the occipital pole, is carried forwards to the anterior part of the pelvis. This mechanism is, in fact, a movement of accommodation to allow the head to take up a position of rest and deflexion in the curved canal.

Primary extension of the foetal head is a continuation of the spiral movement of internal rotation and

descent which helps to keep the long axis of the foetal head in that of the birth canal where it curves forwards. Under favourable conditions it commences in occipito-posterior positions, as soon as the occiput has rotated in front of the transverse diameter of the pelvis, generally when the head is expanding the pelvic floor. At first minor asynclitism or tilting of the head towards the anterior parietal bone followed by slight extension may take place. As internal rotation is nearing completion, the major movement of extension takes place and it ceases when the mento-vertical axis of the head corresponds with the axis of the birth canal, with the vertex expanding the vaginal orifice. This primary extension of the head is brought about by extension of the cervical spine as a whole and, unlike secondary extension, is not a simple hinge -like movement at the atlanto-occipital joint (Jones 1906.) The head is deflexed, the vertex is thrust towards the vaginal orifice like a piston in a cylinder, the cervical spine is opposed to the posterior surface of the pubes and the occiput comes to rest beneath the pubic arch. The movement is largely one of accommodation, the presenting part taking the line of least resistance, to the vaginal orifice as it is driven forward by the transmitted power of the uterus.

William Hunter, from whom much of what is here recorded concerning the mechanism of labour, has been taken, believes that the forward tilting of the occiput toward the front and primary or precrowning extension are different aspects of one mechanism.

Calkins[21] (1947) states that the internal rotation takes place before the head reaches the pelvic floor in two-thirds of cases and rather earlier in multigravida than in primigravidae. If he is correct in his assertion, it suggests that the inclined planes of the pelvic gutter play little or no role in causing rotation of the occiput. The pelvic floor is situated at the level of the angle in the 'L'-shaped birth canal and if rotation is effected before this level is reached, then the theory of 'unequal flexibilities' introduced by Bellheim and developed by Snoo and Moir becomes untenable.

Perhaps studies in animals on the mechanism of labour and the role of the pelvic floor in aiding rotation, may bring some enlightenment. In lower mammals the levator ani arises posteriorly from the brim, whereas in man it has descended to a lower level, leaving its aponeurosis of origin as the tough upper part of the obturator fascia. Morphologically the muscle may

be divided into iliococcygeus and pubococcygeus portions the latter sometimes in man has an accessory slip at its posterior part termed the iliosacralis.[22] The higher level of origin of the levator ani and its better development in lower mammals form a favourable setting for studying the role of this muscle in the mechanism of labour.

FAILURE OF THE MECHANISM OF LABOUR IN OCCIPITO-POSTERIOR POSITIONS.

The mechanism of labour is dependent on the following factors : adequate uterine action, a curved birth canal the soft tissue walls of which are in apposition and which have a degree of elasticity, a foetal head of average size. We may logically state therefore, that when the foetal head is of average dimensions, the lower birth canal of normal calibre and resistance, the pelvic capacity within normal limits and the uterine contractions are effective, compaction and general flexion of the foetus are usually maintained and increased in the course of normal labour. It may be stated also that within reasonable limits, the greater the resistance and resilience of the soft tissues making up the birth canal and the less the available space in the bony pelvis, the greater will be the degree of flexion and therefore spontaneous rotation will be encouraged (Hunter.)

It follows then, that if the foetal head is small, the lower birth canal patulous and atonic, the pelvis too spacious and uterine contractions feeble, the forces bringing about increased flexion may be less effective and the head may remain in an attitude of incomplete flexion. Incomplete flexion from any cause may

bring about a state of rest and equilibrium in which flexion and extension may be effected with equal facility. In the absence of unequal flexibilities there is probably an impairment of the tendency for rotation to occur. The likelihood of non-rotation of the head may be increased if the uterus is inert or hypotonic or if moulding and caput succedanrum formation have taken place on a deflexed head or, in the exceptional case, if foetal rigor mortis is present. Foetal atony or a deficient or inefficient uterine floor may increase the risk of non-rotation in some cases. Some of these factors will be discussed in greater detail.

THE UTERINE ACTION.

Poor uterine action is a well-known feature of the labour in those cases in which the occiput occupies a posterior position. For some obscure reason - Cameron states it is the influence of the polarity of the uterus - the onset of labour is often characterized by irregular feeble, ineffective but painful contractions. A multiparous patient is often conscious of the unusual state of affairs and may volunteer the information that something is wrong with her pains which are different from those of her previous labours. That

this type of poor uterine action can be and often is responsible for the failure of the mechanism of labour is readily understood. The duration of the first stage of labour is not affected by posterior positions of the occiput. All recent workers who have studied the problem are agreed on this. Calkins[23] computed the duration of labour by the number of labour pains and the time in minutes. He compared these findings with those obtained by a similar study in occipito-anterior positions, selecting cases which were as far as possible similar in the initial state of the cervix. He concluded that the occipito-posterior position only slightly lengthened the first stage of labour. Calkins, who has long maintained a sanguine attitude towards occipito-posterior positions, calculates that the second stage is prolonged by as much as 35 minutes; depending upon the associated factors of labour pains, infant size, level at which dilatation is completed and the time in which internal rotation takes place. The difference between Calkins computations and other similar earlier statistical analyses may be due to the fact that the patients with very short labours may have started off as posterior positions, but were first seen when dilatation and rotation were already completed. In the analysis these cases were included under anterior positions. Moreover a relatively larger

percentage of patients with poor contractions, unfavourable cervices or those with large babies and several conditions unfavourable to dilatation, would have been seen very early in labour, increasing the relative incidence of occipito-posterior positions and hereby also increasing the overall percentage of slow labours in this type of presentation. Hellman and Prystowsky, working in Professor Eastman's clinic, obtained similar findings in their studies. In regard to the persistent occipito-posterior position, they conclude that the length of the second stage is more than doubled.

The need for efficient uterine function is greater in occipito-posterior positions if spontaneous rotation is to be achieved. Quite apart from the well-known need for long internal rotation through three-eighths of a circle the mechanism of labour is adversely affected in other ways. The axis of uterine thrust transmitted from the fundus uteri through the foetal vertebral column, tends to operate at a mechanical disadvantage, since it is out of alignment and not at right angles to the pelvic inlet. The steeper therefore the angle of inclination of the pelvic brim the more serious does this factor become. The forces

necessary to drive the head deeply into the pelvis are often misdirected and therefore misspent. It is in this respect that the multipara is blessed with a mechanical advantage, for her more lax abdominal wall allows the uterine body to sag further forward so that the direction of uterine thrust through the foetal spine more nearly approaches the direction of engagement.

Inefficient uterine function is related to the persistent occipito-posterior position as cause and effect respectively; but clinical observation raises the suspicion that the relationship is frequently reversed. The oft-quoted explanation for this is that the deflexed head presents an ovoid rather than a sphere to the lower segment and therefore tends to fit badly so that poor pains result from inefficient stimulation. The fore waters are not plugged efficiently by the presenting part during contractions and the membranes rupture early on so that rotation is discouraged as a result. D. M. Stern and C.W.F. Burnette in an analysis of 198 cases of persistent occipito-posterior position found that the membranes ruptured before half dilatation in 37.2 per cent of cases and after half dilation in 62.8 per cent. The corresponding figures for my series of 388 cases were 45.2 and 50.1 per cent; in 4.7 per cent of cases

the time of rupture was not ascertainable.

The mechanism whereby the cervix dilates is not fully understood. It is postulated by some that it represents merely the relaxation of a sphincter. This might apply to the internal os but not to the external os which is fibrous rather than muscular and what muscle tissue is present is of an immature type. The frequency of cervical lacerations in normal labour is sufficient testimony of the way in which the lower cervix resists dilatation. The bag of forewaters normally play some role as a hydrostatic wedge, but it is not important to the process and, indeed, "other things being equal, dilatation proceeds more quickly when the membranes are ruptured" (Jeffcoate.)[24] The fact that the membranes rupture early in labour in occipito-posterior positions without appreciably lengthening the first stage of labour, supports this view. The outward thrust of the presenting part must inevitably both thin and open up the cervix by circumferential stretching. It is also said that 'a well-fitting presenting part seems to determine the efficient action of the upper segment'(Jeffcoate.)

A cyclic effect may therefore occur in occipito-posterior positions in which a poorly fitting presenting part is responsible for poor uterine action

and this in turn is inadequate to force the head down into the pelvis and so procure flexion and rotation. Uterine factors may be responsible for persistent occipito-posterior positions in another way. This type of case is seen where the membranes have ruptured early in labour with the head still high. Most of the liquor drains away, the uterus becomes more and more tightly applied to its contents and progress becomes arrested labour having ceased before or shortly after full dilation. We see this type of case amongst our non-booked admissions. The patients are nearly always primipara.

A similar type of persistent occipito-posterior position is seen in both multiparous and primiparous patients. In this type of case the uterus is in a state of tonic contraction. Intermittent contractions have ceased and on examination the uterus is found to be small, tender and hard so as to obscure the outlines of the foetus on palpation. Many of these cases are associated with and the result of cephalo-pelvic disproportion. It is in this type of case that Holland[25] used the term 'active retention of the foetus' namely, when tetanic spasm of the uterus, due to irritation, was the end point of a difficult labour.

A LAX PELVIC FLOOR.

One of the factors allegedly responsible for a failure of long internal rotation is a lax pelvic diaphragm and perineum. The role of these soft tissues in the mechanism of labour has already been considered. It is argued that when the presenting part meets the resistance of the pelvic floor, flexion is promoted. Flexion is a sine qua non in the mechanism of anterior rotation. The downward and forward sloping inclined side walls of the diaphragm deflect the occiput and so rotation occurs. A lax pelvic diaphragm can exert no influence on the rotation of the occiput. This age-old concept must be subjected to critical analysis before its validity can be accepted. If this concept is correct or if it is a factor of notable significance one would expect the incidence of persistent occipito-posterior positions to be higher in the higher grades of parity; yet in this series 30.24 per cent of patients had more than two full-term deliveries, 52.68 were primiparae and, the rest had all had only one previous full-term delivery. These figures, which reflect on the parity of the parturients in the series, must be interpreted with caution because of the selection exercised in booking prospective parturients for delivery. The present accommodation inadequacies for our

obstetrical unit makes it necessary for us to select our patients, preference being given to primigravidae, grand multiparae, those with bad obstetric histories as well as those who have chronic medical illnesses. It is therefore difficult to determine how closely our hospital figures represent a cross-section of all parturients. If we turn to the analysis of the parity groups among the non-booked admissions the problem is no clearer because those multigravidae who are admitted to hospital have usually had dystocia of some duration necessitating admission to hospital for further attention. No knowledge is gained of the group which delivered spontaneously and completely in the face-to-pubes position and never entered the portals of a hospital.

Secondly, it can be logically stated that poor muscular resistance to the long occipital lever will mean less liability to extension. (See page 75) Thus even when a potent factor for extension of the head is present the lax perineum can only have a very small contributory role. Lastly, it may be added, that when the head has reached the lax sagging pelvic floor of the multipara it has come a long way through the pelvic straight and if it has not rotated by then the natural forces have

found it unnecessary or impossible. In opposition to these arguments one may say that with a well flexed head having a long frontal lever, a taut perineum will promote additional flexion. But this is hardly pertinent to the problem of persistent occipito-posterior positions.

These arguments cast serious doubts on the validity of the long accepted, but imperfectly understood, concept of a lax perineum as an etiological factor. Certainly, in so far as the Bantu are concerned South African obstetricians will be loathe to accept it as a predisposing factor for, as is well known, the incidence of prolapse in these people is very much lower than in other racial groups in this country yet their incidence of persistent occipito-posterior positions is highest.

If we look upon the normal mechanism of labour as an attempt on the part of nature to pass the irregular spheriod of the foetal head through a pelvic channel of varying cross-sectional shape at different levels, it is easy to understand that the need for these rotatory movements executed by the head is unnecessary if the foetal head is very small or the pelvis very large by comparison. If labour starts off in these cases with the occiput posterior, the foetal head may traverse the whole length of the pelvis without rotation. The multiparous

parturient in premature travail exemplifies this type of case. Here the lax vaginal walls do not embrace the small foetal head and the sagging pelvic floor has failed to maintain the curvature of the birth canal. The second of twins, especially when small, not infrequently is born face-to-pubes; it typifies the type of case just discussed.

FACTORS WHICH RENDER IMPOSSIBLE THE MECHANISM OF LONG INTERNAL ROTATION

The normal mechanism of the occiput in labour is only possible if the pelvic architecture allows. Ordinarily, the bony pelvis does not materially affect the mechanism but, when the pelvis is small or deformed the rotatory mechanics may be disordered or obstructed. The well-flexed head presents at its greatest cross-section as a circle measuring more or less 9.5 centimeters in diameter (depending on foetal size.) Such a fully flexed head can rotate as is necessary in labour. But optimal flexion is not necessarily de novo or throughout labour. The partially extended head presenting by its occipito-frontal diameter has at its greatest cross-section an imperfect oval outline. Its greatest longitudinal length is about II.5 centimeters while its greatest width of 9 - 10 centimeters is situated nearer to one end of the greatest length than the other. A head in such an attitude of partial extension can only move as the accommodating pelvic architecture allows. Pelvic morphology and head flexion are both factors of paramount importance in the posterior mechanism. These two factors will be considered in this section.

1. THE TYPE OF PELVIS.

Reference has already been made to the paradox in Bantu obstetrics namely, that as a race they are unequalled as parturients (in South Africa certainly) yet they run into obstetric difficulties far more commonly than other racial groups in South Africa, when the occiput occupies a posterior position at the onset of labour. This commonly observed difference suggested cephalo-pelvic relationships as a possible cause to account for the disparity in incidence between the Bantu and the other racial groups in South Africa. An investigation was therefore carried out to study the role of pelvic and cranial morphology in the persistent occipito-posterior position.

Pelvic architecture is the most important single factor determining the mechanism of the occiput in labour. This statement applies with equal force to persistent occipito-posterior positions. The occiput being the largest part of the presenting part gravitates to the most roomy area of the pelvis. At the brim engagement as a posterior is more likely with a narrow beaked anterior pelvis and a deep posterior segment. In the midpelvis a deep well curved sacrum and prominent

inward-pointing spines narrowing the transverse dimensions at this station, similarly encourage the posterior position. At the outlet, the posterior position is favoured by a triangular fore-pelvis (with a narrow gothic arch subpubic configuration) and a fully adequate posterior segment. Pipers'[26] assertion that a long symphysis pubis is an important factor in determining the mechanism of the occiput in persistent occipito-posterior positions hardly seems tenable in the absence of further qualification of the statement. The occiput that has come so far forward as to meet resistance in the form of the symphysis pubis has no need for further rotation. The problem is perhaps that of disproportion.

Anthropoid and to a lesser extent android pelves possess many of the features mentioned above. Their side walls are characteristically flattened. In this way they offer obstruction to the mechanism which effects complete flexion of the vertex and long internal rotation. According to D'Esopo 90 per cent of primary occipito-sacral positions can be accounted for on this basis.

Pelvic morphology is one of the two main factors responsible for the high Bantu persistent occipito-posterior rate of 5.2 per cent as well as the poorer out-

come for spontaneous delivery in this type of case. Without proof however, the assumed importance of pelvic form in the causation of persistent occipito-posterior positions as well as its prominence as an etiological factor in the Bantu, would be mere conjecture. The statement concerning its role in the Bantu is based on a radiological survey analysing a consecutive series of unselected women's pelves and conducted with the purpose of determining any variation in incidence of the different pelvic forms as compared with corresponding European types. Studies conducted by Heyns[27] just more than a decade ago revealed a surprising finding namely, that the capacity of the average Bantu woman's pelvis is lower than for example that of English women. This fact is referred to elsewhere in this work. Ince and Young[28] found the average area of the brim in London English women to be 126-8 square centimeters whereas the corresponding figure for the Bantu was 101.23, the largest brim of a series of 67 dry pelves being equal to Ince and Young's average. This reduction in brim area is the result of smaller measurements in both the transverse and the antero-posterior dimensions (see table 16 -) so that the brim index does not differ materially from the normal as Heyn's and my own (Appendix I) figures demonstrate. These figures are reproduced in tables 8 & 9

COMPARATIVE FIGURES FOR BANTU AND ENGLISH URBAN AND RURAL POPULATIONS.

TABLE 8.

PELVIC DIMENSION.	ORIGIN	NO. OF OBSERVATIONS.	MEAN	RANGE
A.CONJUGATE VERA. (C M)	BANTU	a) 66 Dry Pelves	10.76 ± 0.10	9.1 - 12.6
		b) 100 X-Ray Pelvimetries	10.59 ± 0.08	8.2 - 12.5
		c) Stereoscopic Method (25)	11.01	
	RURAL ENGLISH	350 X-Ray	11.64	8.35-14.35
	LONDON ENGLISH	509 Pelvimetries	11.83 ± 0.04	8.7 - 15
B.TRANSVERSE OF BRIM (CM)	BANTU	a) 66 Dry Pelves	11.96 ± 0.10	9.8 - 13.8
		b) 100 X-Ray Pelvimetries	11.34 ± 0.08	9.15-13.6
		c) Stereoscopic Method	12.07	
	RURAL ENGLISH	350	13.23	11.0-16.0
	LONDON ENGLISH	509	13.06 ± 0.03	10.9-15.4
C.CALCULATED AREA OF INLET	BANTU	a) 66 Dry Pelves	101.23± 1.25	74.75-126.8
		b) 100 X-Ray Pelvimetries	99.33 ± 1.21	66.6- 127.6
		c) 25 Stereoscopic Method	113.04	
	RURAL ENGLISH	350	121.0	86.0-162.0
	LONDON ENGLISH	509	126.80± 0.66	95.0-165.0

BRIM INDEX. COMPARATIVE FIGURES FOR BANTU AND ENGLISH WOMEN.

TABLE 9.

	ORIGIN	INDEX
BANTU HEYNS	a) 65 Dry Pelves b) 100 X-Ray Pelvimetries. c) 25 Stereoscopic method.	90.35 ± 1.62 93.60 ± 0.72 91.27
See Appendix 1. Page	305 X-Ray Pelvimetries	92.3
ENGLISH	350 Rural English 805 London English	88.3 90.80 ± 0.36
SOUTH AFRICAN COLOURED	100 X-Ray Pelvimetries.	90.2

My own studies indicate also the strong android tendency in Bantu pelvic morphology. Thus android android-gynaecoid, android-anthropoid and android-platypelloid forms constituted 34.7 ± 2.727 per cent of 305 cases investigated, whereas the corresponding figure obtained by Caldwell and Moloy was only 22.2 per cent - a difference of 12.5 which on statistical analysis is found to be 3.181 times the standard error. Statistically, therefore we cannot ignore this difference. It is also shown (Appendix I page 113) that the percentage of all forms showing an android tendency in 305 Bantu women is 46.8 per cent - a figure which is significantly higher (3.142 times the standard error of difference) than that of the Caldwell-Moloy series (33.3 per cent.)

The smaller size of the Bantu pelvis and the higher incidence of android forms are primarily responsible for the poorer chance for spontaneous delivery when the occiput occupies a posterior position in these excellent parturients. The foetal head, which is of comparable size (Appendix II) to that of the caucasian, has not only to traverse a smaller pelvis but a longer one as well. The subpubic angle is more often below 80 degrees, than for example in the Cape Coloured (Appendix I page 118) yet the intertuberous diameter is not below

normal (Heyns) so that the foetal head has to traverse a greater depth before birth by extension becomes possible.

The android pelvis with its wedge-shaped brim and converging side-walls, has a particularly bad obstetric reputation. A moment's thought will provide one reason for this: the widest diameter of the brim is situated far back near the posterior wall where it is not available to the foetal head. The diameter that does concern the foetal head lies halfway between the anterior and posterior walls and is conveniently termed the available transverse diameter by Moir.

Whereas in the gynaecoid pelvis with its rounded elliptical brim, these diameters coincide or nearly coincide and are therefore equal, in the wedge-brimmed pelvis the available transverse diameter may be two or more centimeters less than the widest transverse measurement. It is a treacherous type of pelvis. Sometimes the sacrum lacks a full concavity from promontory to tip. In these circumstances the head engages as a posterior but because of inadequate sacral curvature and prominent inward - pointing spines, resistance is offered not only to the descent of the head but also to internal rotation (when the occiput is posterior.) When the

occiput meets the resistance of the imperfectly curved sacrum, extension is promoted, as will be shown later. A greater head diameter presents, namely, the occipito-frontal and because of the convergent bore of the side-walls, the progress of labour is arrested. It is with this type of pelvis that the entity "failed forceps" is most often seen recorded in posterior positions. At the outlet the narrow, deep subpubic arch diminishes the lower available antero-posterior diameter, and so difficulty is encountered even in the final stage of expulsion (or extraction) while the danger to the soft tissues is greater because of this narrow 'gothic arch' subpubic configuration in which the waste-space of Morris is greater than with wider arches. The percentage of Bantu women having a subpubic arch below 80 degrees is high - higher than, for example, in the Cape Coloured primigravidae studied (Appendix I) Caldwell and Moloy state that narrow arches are 'associated with converging side walls in 100 per cent of cases studied.'

The role of pelvic shape on the incidence of occipito-posterior positions as well as the course and outcome of labour is an important one. The exact mechanism by which android and anthropoid pelves are concerned in the causation of persistent occipito-posterior

positions will be discussed later under 'Extension of the foetal head during labour.' If pelvic configuration is so important a determining factor in the incidence of persistent occipito-posterior positions one should be able to prove statistically the following :-

a) That the incidence of occipito-posterior positions at the onset of labour is greater in android and anthropoid pelves as compared with other types.

b) That the incidence of persistent occipito-posterior positions (whether the delivery was spontaneous or was terminated by forceps extraction or caesarean section) is directly related to these pelvic forms.

The tables which follow, were compiled from the case histories of patients delivered at the Somerset hospital. All the patients had complete X-ray pelvimetries antenatally. They were both of Bantu and Coloured stock.

From the figures in table Io it can be seen that

the head engaged in the occipito-posterior position in 35.23 per cent of 176 android pelves. Of these posteriors, spontaneous anterior rotation took place in only 46 per cent of cases. In the anthropoid group spontaneous rotation was the exception, occurring in only 25 per cent of cases or one in four labours.

TABLE IO

TYPE OF PELVIS	NO. OF CASES.	POSITION AT ONSET OF LABOUR.		MODE OF TERMINATION.	
		O-A	O-P	O-A	P. O. P.
ANDROID	176	114	62	142	34 (54.8%)
GYNAECOID	200	169	31	195	2 (6.4%)
ANTHROPOID	50	19	37	29	27 (75%)
PLATYPELLOID	64	52	12	62	2 (16%)

O-A Occipito-anterior ; O-P Occipito-posterior.
P-O-P. PERSISTENT OCCIPITO POSTERIORS. % FAILURE OF ROTATION

In regard to the platypelloid forms in only approximately one in five cases was the occiput posterior at the onset of labour and complete rotation was achieved in five out of every six cases (83.3 per cent.) Ninety three per cent of posteriors in the gynaecoid group

rotated spontaneously and completely.

The obstetrically unfavourable android pelvis is clearly shown up by comparing the outcome of labour in two series of cases with the occiput anterior and posterior in each group. For many years now it has been urged that our forceps rate is too low in the Cape Town teaching hospitals, and that an increase would be an advantage to our patients as well as to those in training without militating against the principles of good obstetric practice. Heyns[29] mentions the same problem in his 1947 paper (The South African Negro or Bantu as a Parturient,)and states that the incidence of 1.82 per cent for South African whites is appreciably lower than the rate of over 5 per cent in most European communities elsewhere. In his series the Bantu forceps rate was 0.21 per cent. These figures reflect on the excellence of the Bantu as parturients. Yet from my own studies it is shown that in the persistent occipito-posterior position, this excellence disappears and the operative and assisted delivery rates increase (page 15) It is submitted that the strong android tendency in Bantu pelvic morphology is primarily responsible for this unfavourable prognosis in persistent occipito-posterior positions.

COMPARATIVE FIGURES FOR THE OUTCOME OF LABOUR IN OCCIPITO-ANTERIOR AND OCCIPITO-POSTERIOR POSITIONS IN 108 ANDROID PELVES.

TABLE II.

POSITION OF OCCIPUT	TOT. NO. OF CASES	SPONTANEOUS	FORCEPS	CAESAREAN SECTION
OCCIPITO - ANTERIOR	61	55 (90.2%)	2 (3.3%)	4 (6.55%)
OCCIPITO - POSTERIOR	47	30 (63.9%)	9 (19.1%)	8 (17.0%)

Ordinarily, the exceptional fortitude and good uterine action of Bantu parturients enable them to cope with the task of driving the foetal head through the smaller pelvis; but when the additional task is imposed upon them of having to deal with the unfavourable persistent occipito-posterior position, a large proportion of them fail to achieve a normal delivery. In the series quoted in table II , the forceps rate is almost six times

as high when the occiput is posterior at the onset of labour in android pelves; the caesarean section rates show a similar, though less marked, increase.

The worst cases of extreme moulding are encountered among Bantu parturients with persistent occipito-posterior positions. Often the case is an emergency admission - and 20 to 30 per cent of our deliveries at the Somerset hospital are non-booked admissions admitted because of a prolonged second stage. On inspection of the vulva a large caput is seen and a vaginal examination gives the deceptive impression that the head is low enough to be extracted by forceps. Subsequent events prove the fallacy of the impression that the head was low in position. Moulding in these cases may so distort the head that even the experienced obstetrician may form a wrong impression as to the station of the head.

The following table shows the relative frequencies of the different modes of termination of labour in all pelvic types when the occiput is posterior at the onset of labour.

These figures speak for themselves. The two cases of anthropoid pelvis which came to caesarean section both were of the 'high assimilation' type. The worst prognosis

with occipito-posterior positions is found in association with android pelves. The gynaecoid and anthropoid forms offer the best chance for natural delivery.

TABLE I2.

TYPE OF PELVIS	NO. OF CASES	MODE OF TERMINATION			
		SOA	SFTP	FORCEPS	C.S.
GYNAECOID	50	92%	2%	4%	2%
ANDROID	47	39.7%	4.2%	19.1%	17.0%
ANTHROPOID	40	62.5%	25%	7.5%	5%
PLATYPELLOID	40	80%	7.5%	5%	7.5%

SOA = Spontaneous delivery with the occiput anterior.
SFTP = Spontaneous delivery in the face-to-pubes position.
C.S. = Caesarean section.

What is written here in condemnation of the android pelvis in occipito-posterior positions, applies to

a lesser degree to vertex presentations in general. It is of interest to reproduce the figures from Caldwell and Moloy, who studied the distribution of pelvis types according to the mode of delivery.

These figures show that for 'low forceps' there is very little variation in incidence relative to the individual pelvic types. This is not surprising, the incidence of this proceedure varies from obstetrician to obstetrician. But no obstetrician would readily or unnecessarily do a 'low-mid forceps' or a 'mid forceps' and it is under these headings that the android pelvis is exposed in its true colours. The same may be said of caesarean deliveries.

The influence of pelvis structure on the course of labour is an important one. As far as occipito-posterior positions are concerned it must be regarded as a factor of paramount importance. Certainly, as shown, android and anthropoid pelves are associated with a higher percentage of cases of occipito-posterior positions. One of these structural factors is concerned in the high Bantu persistent occipito-posterior rate of 5.2 per cent. The full significance of these pelvic structural influences in the etiology of persistent occipito-posterior positions becomes more evident when considered in conjunction with

DISTRIBUTION OF PELVIC TYPES ACCORDING TO THE MODE OF DELIVERY 500 Cases.

(FROM CALDWELL AND MOLOY.)

TABLE 13

Mode of Delivery.	Anthropoid.	Anthropoid-Gynaecoid.	Android-Anthropoid.	Gynaecoid.	Android.	Android-Gynaecoid.	Gynaecoid-Flat.	Android Flat.	Rachitic Flat.	No. of Cases.
Spontaneous.	I0	I5	9	37	I0	8	5	4	0	I00
Low forceps.	I6	I5	I0	32	I6	5	3	2	0	I00
Low-mid forceps.	I3	I0	I2	I2	2I	I4	5	9	0	I00
Mid forceps.	I2	2	I2	I5	35	9	6	8	0	I00
Caesarean Section.	II	5	9	I2	4I	7	3	6	4	I00

extension of the head and cranial form.

II. THE CRANIAL CONFIGURATION AND EXTENSION OF THE FOETAL HEAD.

A) THE SHAPE OF THE FOETAL HEAD.

For many decades it has been taught that the inherited cranial form influences the course of labour. Ernest Philip[30] of Kiel, in criticising this view states that these time-honoured teachings are based on the examination of children who were already delivered spontaneously, and whose heads, accordingly, had been moulded by the course of labour. He examined hundreds of cases of breech delivery in which 'the head could not have been moulded.' He found what is generally known, namely, that the rounded brachycephalous type predominated to the exclusion of all other types. His conclusion was that ".....in the newborn there is not yet any congenital inherited cranial form, at any rate, not in such a way that any influence on the course of labour could be expected," whilst Fink[31] in his paper concluded, from his series of cases, that cranial configuration "is not a very impor-

tant factor in influencing the course of labour." Fink [31a] studied the problem in a more specific manner, namely, in regard to persistent occipito-posterior positions, and reached the conclusion that one of the important etiological factors is a foetal head similar to the shape of the pelvis being characterized by a longer bitemporal and mento-occipital diameter than normal.

Opinion seems divided as to the role of cranial configuration on the course of labour. In several personal communications obstetricians mentioned the possibility that the pelvic shape influences the cranial form. While this view may be correct in regard to the moulding which takes place in cases of minor disproportion, there certainly is no fixed relationship between, say, a dolichopellic bony birth canal and a dolichocephalic cranial configuration. The question is discussed in Appendix II of this work.

The only known and proven relationship between head form and presentation is that which exists between anencephaly and face presentation. The cranial form probably has a very small role in influencing the presentation or affecting the mechanism of labour; but when head shape is considered in relationship to occipito-posterior positions in certain pelvic types there becomes

apparent a definite relationship.

The South African Bantu have heads which are elongated so that the ratio of the greatest breadth to the greatest length is of an order to which the term dolichocephaly is applicable. The index for these measurements is 72.5 (Keane)[32] and according to J.A. Keen 71.8.[33] These indices indicate that they are among the most dolichocephalic of the various ethnic groups. We know also that term infants' heads fall within a restricted range of 78 - 82 for the length/breadth index and that the subsequent maturation curves for infants of different racial groups show differences with time, these differences being related to the index of the parents. In Appendix II (page 175) is to be found a discussion and study of the term infant's head in the Bantu and the Cape Coloured people. In that section the conclusion is reached that the term Bantu foetus' head has a cephalic index of 78.53, while the Cape Coloured infant has an index nearer the upper limits of the accepted range. It is also shown that the difference in index is greater than can be accounted for by chance. A study of the individual case records (page 177) shows the frequency with which infants with low cephalic index (75 - 76) is encountered among the Ama-Zulu and the Ama-Xosa and that it is the occurrence of these exceptionally low indices (i.e. low for term infants) which

lower the overall average index of these tribes to 78.4.

The cephalic index expresses something different for each skull and it must be regarded as a total response to a number of variable factors. Arithmetically the index merely expresses skull breadth as a percentage of skull length. In actual fact a low index is such because the head is elongated posteriorly that is, at its occipital end.

In this discussion we are concerned primarily with those foetuses who at term have a cephalic index which is appreciably lower than the accepted average. The suboccipito-bregmatic diameter which presents when the head is fully flexed, as in occipito-anterior positions, is unchanged by variations in the cephalic index. But with partial extension a different diameter is concerned. If we consider the example where the degree of extension is sufficient to change the girdle of cranial contact from the suboccipito-bregmatic to the occipito-frontal plane, then it is easy to see how the sectional shape becomes changed from a circle to an oval. If in addition there is a low cephalic index, the oval shape becomes more pronounced. This is the median vertex position first described by Baudelocque and Hodge and is also referred to as the 'Military Attitude.'

Both the dolichocephalic and the paedocephalic heads have a circular cross section in the suboccipito-bregmatic plane; as extension takes place so does the cross-section at the girdle of cranial contact become more oval. Consider a degree of extension which is less than that quoted in the first example, that is, one in which the greatest sectional plane is anywhere between the sub-occipito-bregmatic and the occipital-frontal planes: for any given degree of extension the dolichocephalic skull will have a more markedly oval outline at the girdle of cranial contact than the paedocephalic skull.

If partial extension of the passenger's head occurs in a pelvis which for any reason is narrowed transversely the mechanism of labour cannot take place. This applies particularly to the anthropoid pelvis which may be transversely contracted and often compensated for in its antero-posterior dimensions. The same may be said of the android class of pelvis in which the narrowing is in the midpelvis but which is not compensated for in any other dimension.

It is rational to conclude that the long axis of the head (in the attitude of partial extension) will be in the longest diameter of the pelvis in these cases, to facilitate delivery - to minimize the maternal and uterine

effort necessary for expulsion. Therefore an occipito-posterior position must be regarded as a physiological adaptation of foetal head to maternal pelvis in this type of case. Such adaptation is necessary when the foetal head diameters which are of importance in labour, approximate the available pelvic dimensions in magnitude. Naturally the question arises: Why do not all parturients with android and anthropoid pelves deliver as posteriors or terminate with the occiput lagging in the posterior position when labour started off with the occiput posterior in location? The answer is that this obligatory adaptation of the foetal head to the maternal pelvis is only necessary when the head (by virtue of its size, or degree of extension) can just traverse the pelvic strait and requires the optimal position in order to achieve this. Conversely if the foetal head is very small and the pelvis very large, no adaptation is necessary. In a spacious and so completely rounded pelvis that all its measurements are practically the same, adaptation is unnecessary; the head, then, may equally well be born as a 'posterior' or an 'anterior.' It is noteworthy that the labour which terminates as a persistent occipito-posterior often has a large infant as a passenger. Indeed, the average weight of all 'persistent occipito-posterior positions' in my series were above average (See table 4) The

second of twins and the premature labour typify the class of case in which a small foetal head traversing a capacious pelvis, renders the need for a mechanism of labour superfluous. Not infrequently the infant's head engages as a vertex in the posterior position and passes the length of the pelvis without rotating and is born 'face-to-pubes.'

II. EXTENSION OF THE FOETAL HEAD.

The importance of extension in the posterior position has been mentioned by nearly every writer on the subject. It appears to be a well established aspect of the posterior mechanism, yet its cause has not been well understood. When the membranes are ruptured the effective force of uterine contraction and retraction is exerted largely by pressure of the fundus on the upper pole of the foetus and this is transmitted directly to the presenting part through the vertebral column. Irrespective of the behaviour of the uterine muscle, there must be a resultant downward force transmitted through the foetal spine, which becomes straight and rigid in labour. (Illustration *ii*) This force is applied to the foetal head at the foramen

magnum. It results both in descent of the head and a torque motion around the atlas. This torque motion will result either in flexion or extension, depending on the lengths of the two lever arms formed. The lengths of these two lever arms are determined by projecting the line of force, through the foetal spine and the foramen magnum to the girdle of cranial contact, the exact plane of which is dependent on the degree of flexion or extension present. Thus in the fully flexed attitude it corresponds to the suboccipito-bregmatic plane whereas in the median vertex position it is related to the occipito-frontal plane. Labour, in occipito-posterior positions often starts off with the head partially extended, so for the purpose of this discussion only the mechanism in relation to the occipito-frontal plane will be considered. Moreover, when the head is <u>fully flexed</u> at the onset of labour it as a rule remains in this attitude throughout its pelvic descent. By contrast the partially extended head may either become fully flexed, or it may extend further and be responsible for a failure of progress of labour; as a third possibility the extension may be progressive and ultimately convert a vertex into a face presentation. Since we are here concerned with the partially extended head the lever arms will be determined by projecting the line of force to the occipito-frontal plane.

It is upon the cranial plane of greatest friction that the forces which produce flexion or extension become operative. Extension will therefore result when the line of force through the foetal spine intersects the long axis of the cranial plane of greatest friction in such a manner that the occipital lever is greater than the frontal. The following x-rays of patients in labour illustrate this point.

ILLUSTRATION I.

The patient was a twenty year old Xosa secundipara, who attended the antenatal clinic for the first time at the thirty-second week of gestation. Her first labour (1954) took place in the reserve and the scant details concerning her previous history were obtained with some difficulty. The membranes ruptured before the onset of labour, preceding it by some ten to twelve hours. Pains then followed but for the first twenty-four hours they were weak and infrequent. The contractions of the second twenty-four hours were stronger and recurred at more frequent intervals and towards the end of this time she began to bear down - an effort which lasted for three to four hours and was followed by the birth of a stillborn infant. The patient was unattended during labour.

After her first attendance at the antenatal clinic the patient defaulted and when next seen was in strong labour. She was admitted after six hours of pains.

The findings on examination were as follows.

Her general condition was satisfactory, the temperature being normal, the pulse eighty-two, the blood pressure 110/70 mm Hg., and the urine was free from albumen.

On abdominal examination the height of the uterine fundus was that of a full-term gestation; the lie of the foetus being longitudinal, the vertex presenting in the right occipito-posterior position. The head was not engaged nor could it be pushed into the pelvic cavity. The foetal heart rate was 112.

On vaginal examination the cervix was found to be three fingers dilated, the membranes having ruptured; no cord was felt. The head was high and the anterior fontanelle could readily be felt. The pelvis was not considered adequate for the size of the head; the outlet was grossly contracted.

A caesarean section was decided on. However, the patient refused consent to any operation and began to

bear down uncontrollably. An X-ray taken shortly after admission is reproduced here. It shows the head above the brim of the pelvis and already considerably extended. A second vaginal examination forty minutes after admission revealed the head at a much lower level but still not engaged. Extension had increased and the anterior fontanelle was palpated with even greater ease. No further extension or descent of the head were noted in the following half-hour although the cervix was by then fully dilated.

The timely arrival of the patient's husband on the scene avoided a catastrophe. With his persuasive tongue he prised consent from her. A caesarean section was performed just less than two hours after admission and a live infant weighing seven pounds five ounces delivered.

An X-ray pelvimetry in her following pregnancy (1957), showed the pelvis to be android in type. The inlet and outlet views are reproduced here. (Illustrations la and lb.

ILLUSTRATION II. Shows the straightening of the foetal spine which occurs in labour.

ILLUSTRATION I

ILLUSTRATION Ia and Ib.

By placing the foetal spine in different positions, its influence on the relative lengths of the occipital and frontal levers is demonstrated.

TABLE I4.

POSITION OF FOETAL SPINE	OCCIPITAL LEVER. (O)	FRONTAL LEVER (S)	RATIO $\frac{O}{S}$	ANGLE
ACTUAL POSITION	36	26	1.38	APS=I08
HYPOTHETICAL POSITION I	30	33	0.9	APS$_1$= 90
HYPOTHETICAL POSITION II	24	40	0.6	APS$_2$= 68

The further forward the foetal spine in occipito-posterior positions, as in multiparous parturients (hypothetical position II,) the more acute is the angle subtended by the projected line of force along the foetal spine to the occipito-frontal plane and the frontal lever, and the greater is the tendency to flexion and therefore rotation and spontaneous delivery because of relative shortening of the occipital lever. This patient had an eleo-

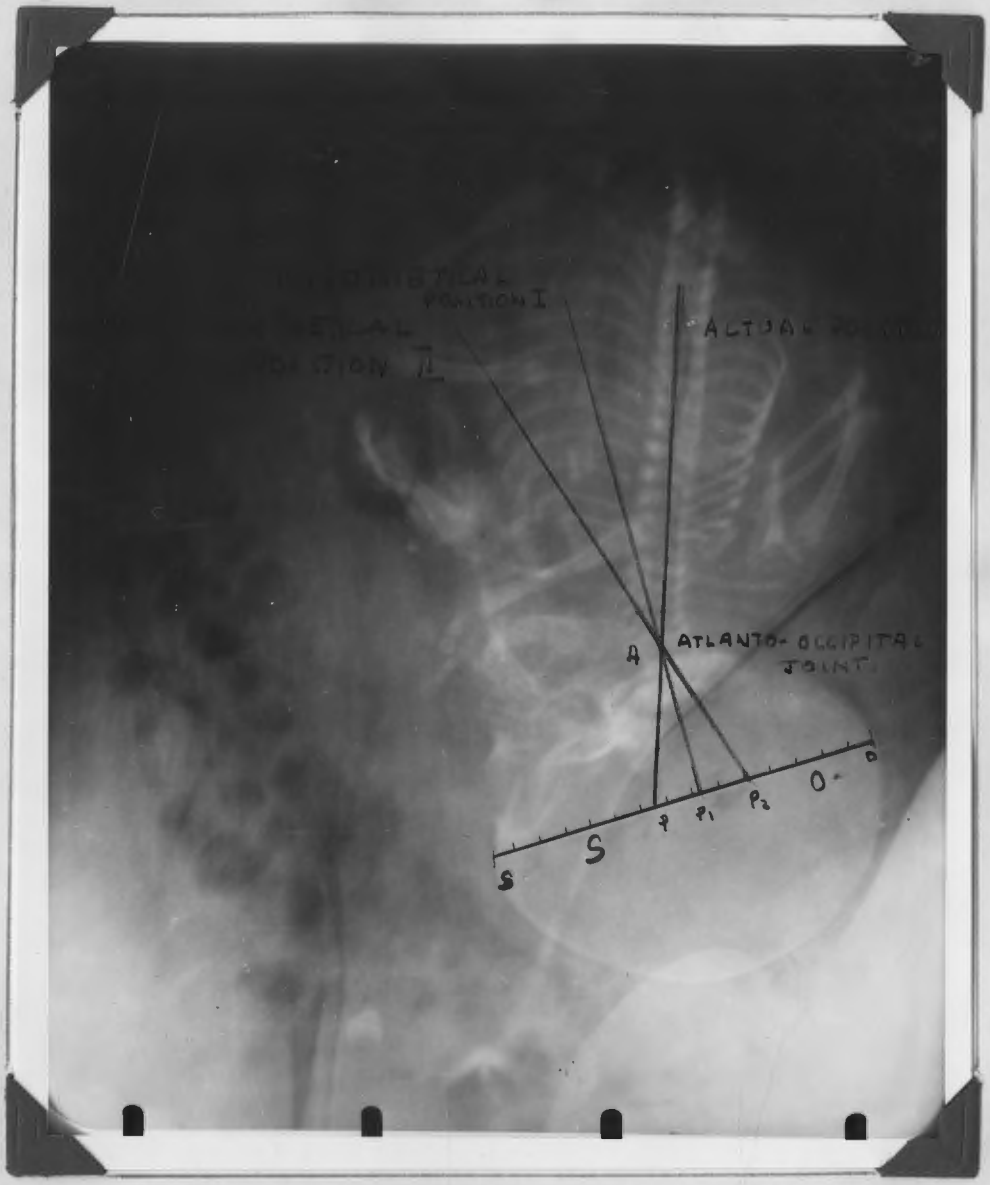

ILLUSTRATION II.

tive caesarean section. The infant's cephalic index was 74.6.

ILLUSTRATION III.

This parturient was a 23 year old Coloured woman admitted because of ruptured membranes. The position of the foetal head was right occipito-posterior. The X-ray was taken before labour commenced and shows the disparity between occipital and frontal levers, this being produced by the excessive smallness of the occipital lever because of marked brachycephaly. Compare the angle subtended by the projected line of force along the foetal spine and the frontal lever with the angle AP.S (Hypothetical position I) of illustration II: the difference is only nine degrees; yet the frontal lever is much greater in Illustration III.

The patient went into labour and during a vaginal examination just before full dilatation the progressive flexion, descent and rotation of the head could easily be followed by the hand in the vagina.

The infant weighed eight pounds at birth and showed very little moulding. The occipito-frontal and biparietal measurements were taken and the cephalic index computed. It was found to be 82.3. This is not a true index because the

ILLUSTRATION III.

head showed a degree of moulding. But when one considers that the effect of moulding with the head in an attitude of flexion, is to impress dolichocephalic features temporarily on the skull, the index of 82.3 indicates that the head was even more brachycephalic than this figure would indicate. (Moulding is discussed in Appendix II.)

ILLUSTRATION IV.

This is the same patient as in the previous illustration. Labour had commenced six hours previously. The following are to be noted.

a) Flexion is becoming more marked.

b) The head is at a lower level.

c) The girdle of cranial contact has therefore been changed from the occipito-frontal to the sub-occipito-bregmatic plane and therefore from an oval to a circle.

d) The parturient had a gynaecoid pelvis.

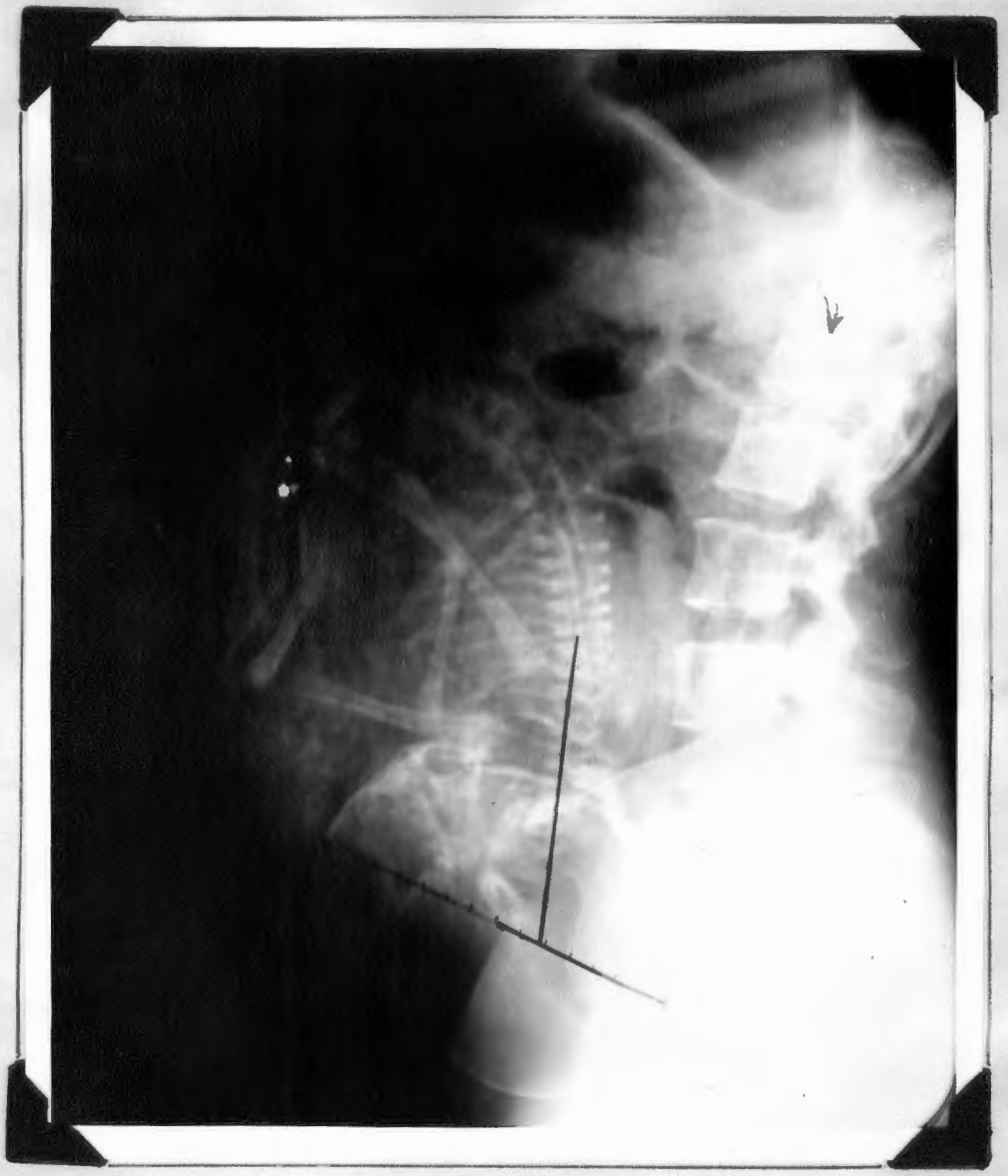

ILLUSTRATION IV.

ILLUSTRATION V.

This shows a case of low cephalic index delivered by elective caesarean section at term. The patient's history is as follows :-

RACE : XOSA AGE : 38 PARA III

HEIGHT 5feet 3 inches.

1) First pregnancy(1940) : The membranes ruptured at the onset of labour. After 24 hours of good pains she was delivered by caesarean section. The head at the time of operation had not yet engaged. The cervix was almost fully dilated. The indication for the termination of labour was foetal distress. The position of the head at the onset of labour and at caesarean section is not known. The infant weighed six pounds 4 ounces at birth. (East London.)

2) Second pregnancy (1948) : She was allowed a trial labour at the Somerset hospital. The head was not engaged at the onset of labour but engaged shortly after the membranes ruptured (twelve hours later.) After 28 hours of good labour the foetal heart became irregular and rose in rate. The position of the head was right occipito-posterior; its biparietal diameter was just above the ischial

Illustration V

spines. Because the cervix was not yet quite fully dilated a caesarean section was performed and a live infant weighing 6 pounds 9 ounces delivered. X-ray pelvimetry showed the pelvis to be andreid in type and of normal dimensions.

3) Third pregnancy: An elective caesarean section was performed. The head was not engaged at the time of operation. The position of the head was left occipito-posterior. The infant weighed six pounds eight ounces.

The cephalic index, determined on the first day, was 74.8.

From these illustrations it is seen that there are three factors modifying the lengths of the two lever arms formed, namely :-

a) The position of the foetal spine - the further back the foetal spine the greater the occipital lever because of the obtuse angle APS (Illustration II.) Thus in the grand multipara with a pendulous

In its descent these two lever arms, of unequal length meet the resistance of the bony pelvis, and it is a simple law of physics that the longer lever will rise thereby producing extension of the head. The immediate result of this is to alter the sectional shape of the head taken at the plane of greatest diameter from a circle

abdomen the frontal lever is greater than the occipital and flexion is promoted. Because of this and other factors labour proceeds satisfactorily. In this way she compensates for a high inclination of the pelvic brim so that the direction of uterine thrust through the foetal spine is in the axis of the pelvis and less force is wasted.

b) The presence of dolichocephaly or a lower index than normal, though it may not necessarily fall within the definition of this type of headform, as laid down by anatomists and physical anthropologists.

c) The degree of extension already present to initiate the unfavourable process which is often

cular type of case is not quite correct.

There is an aspect of the mechanism of extension which has not been considered. Up to this point, in this discussion, it has been assumed that the occipital and frontal levers meet with equal resistances, so that the moment of force at any particular point is determined solely by the lengths of the two lever arms. We have now to consider the type of case in which the resistance is localised, so that only one lever is affected and in consequence the deciding factor which determines whether the head is to flex or extend, is not necessarily the relative lengths of the two lever arms.

In the occipito-anterior position the wide biparietal diameter of the head lies in a relatively spacious portion of the pelvis, approximately in a line drawn from the sacro-iliac synchondrosis to the pubic symphysis, while the narrow bitemporal diameter has to contend with the small sacro-cotyloid diameter (3½ inches) which extends from the sacral promontory to the inner surface of the acetabulum. Exactly the reverse obtains if the occiput is situated posteriorly as the biparietal diameter of the head lies in the small sacro-cotyloid diameter.[34.] Doubtless the circumstance is responsible for

extension of the head in some cases - namely, those pelves in which the sacro-cotyloid diameter is short enough to delay or even arrest the descent of the parietal diameter which is situated above and behind the external auditory meatuses and therefore nearer the inion than glabella.

If sufficient extension occurs for the forehead to be lower than the occiput, the former strikes the pelvic floor resistance first and is deflected anteriorly, so that the occiput rotates to the hollow of the sacrum. The head at some point between the anterior fontanelle and the root of the nose impinges on the symphysis. The head is born by a movement of extreme flexion which is facilitated by a well curved birth canal. The occiput is gradually pushed down and over a greatly distended perineum which may be extensively lacerated 'because of the greater occipito-frontal diameter.' (Cameron)[34]. Probably the biparietal diameter is not blameless in inflicting these lacerations, for it is situated further back than in occipito-anterior positions and in consequence the perineum is subjected to greater forceful stretching and is torn.

The mechanism just described is not an unfa-

vourable one; it is permitted by pelvic adequacy but not all cases in which the biparietal diameter is caught up by the sacro-cotyloid resistance terminate this way.

In another type of case the biparietal diameter is caught up by the small sacrocotyloid diameter and extension takes place as before. But because the sacral curvature is not well developed, the antero-posterior dimension of the mid-pelvis is unable to accommodate the increasing diameter of the extending head. The course of labour is arrested and the case becomes one of persistent occipito-posterior position requiring assistance.

It is of interest to note the mechanism of face presentation. The most frequently encountered is the secondary face presentation which is brought about by gradual extension of the already partially extended head. It is therefore encountered commonly in multiparae who have born gradually larger and larger children, usually as occipito-posterior deliveries.[35] When the position is occipito-posterior there has to be ample room in the hind pelvis for the semi-extended head to slide posteriorly, and to allow the sinciput to slide down behind the pubic rami. If the head is large, or if the pelvis is slightly small, then it is easy to imagine that the widest diameter could get held up posteriorly so that the force directed through

the foetal spine would cause the sincipital end of the head to go down first. This is the way in which the quadrupeds deliver themselves. A wide range in variety in respect of the Brim index is provided by the members of the group mammalia - the value varies from 121 (Simii, Hylobates) to well over 144 (lemuroidea) in most members. All these quadrupeds deliver themselves as what amounts to face presentations. The chimpanzee has an index of 97 and in this mammal there is a lack of the constancy in the position of the head at birth, which characterizes delivery in those animals with indices well over 100. Up to 1943 forty-nine births of chimpanzees were reported in English literature. In only 11 cases was a vertex presentation determined. (The habits of the chimpanzee render observation of labour almost impossible.) In only 4 cases was the actual delivery of the head seen, being occipito-posterior in two cases and occipito-anterior in the remaining 2 observations.

In humans an anthropoid pelvis is usually associated with a favourable outcome of labour whether the occiput be anterior or posterior in position. With complete flexion of the head, there is of course no reason why long internal rotation should not occur, for the suboccipito-bregmatic circular outline of cranial contact is not affec-

ted by the increased antero-posterior dimension of the bony pelvis, provided the shortest transverse diameter of the pelvis can adequately accommodate the circle of the fully flexed head. Should the labour start off with the head in an attitude of partial extension, flexion may be increased as labour progresses. If, however, the biparietal diameter of the head is held up by a transverse narrowing of the pelvis in its posterior third, or if the descent of the occiput is impeded by the restriction of space imposed by a poorly curved sacrum, (as in a high assimilation pelvis) extension will be increased, so that the oval of the pelvis will be occupied by the oval of the extended foetal head, and the course of labour may be arrested or posterior rotation of the occiput will occur, the occurrence of which events, being determined by the architecture at the level of arrest and the uterine action.

III. OTHER ETIOLOGICAL FACTORS OF DOUBTFUL SIGNIFICANCE

1) Prolapse of an arm in front of the occiput preventing forward rotation.[36]

2) Anything which mechanically prevents anterior rotation of the head (or the back) such as tumours of the

> uterus, scars in the uterus which give the lower uterine segment an irregular shape and dysharmony of action between upper and lower segments (de Lee)[36].

3) Persistent asynclitism.

Doubtless these factors can all, on occasion, be associated with and responsible for a persistenc occipito-posterior position. They are uncommon causes. In my series of 12,000 consecutive deliveries there was not one instance where any of these factors were primarily responsible for a persistent occipito-posterior position. Persistent asynclitism is often seen as an adaptive mechanism in relation to the flat pelvis. But here, in the majority of cases the outlet is so satisfactory as to permit complete rotation and an occipito-anterior delivery. Persistent posterior asynclitism has its own peculiar attendant circumstances in which the pelvic abnormality is often so gross as to constitute the major problem, rather than the associated posterior position of the occiput. It angurs badly for spontaneous delivery if it persists.

In summation it may be said that the etiology of persistent occipito-posterior positions is not completely

understood. Different writers stress different factors as the most important - factors which all authors admit as having a contributory role. The literature is characterised by a gross lack of unanimity of opinion in regard to the etiology. An attempt has been made here to obtain a better understanding of the factors responsible for the condition, by specifically investigating it in the Bantu, using the Cape Coloured as a control. Utilizing the difference in incidence between the two peoples as a starting point, an analysis was made of the factors responsible for this disparity and, by applying the knowledge so gained to the problem in general, the following conclusions may be recorded.

a) The structural characteristics of the pelvis play a primary role in determining the occurrence of persistent occipito-posterior positions. The class of pelvis concerned is that which is narrowed transversely for any reason, having, at its brim, a deep adequate posterior segment, and a fore-pelvis inadequate for allowing the passage of the occiput.

This pelvic type predisposes to the occipito-posterior position. In the descent of the head, the pelvis with a sacro-cotyloid diameter offers resistance to the occipital lever and extension is promoted. In the Bantu, pelvic architecture plays an important role and is one of the factors primarily responsible for the high rate of 5.2%. It achieves this by being concerned in the higher proportion of cases which engage as posteriors, as well as the greater number which fail to rotate spontaneously and completely. The posterior position is twice as common in the negro as in the Caucasian (Vartan)[37].

The strong android tendency in Bantu pelvic morphology is demonstrated. The difference in the frequency of all android types as compared with, for example, Ameri-

-can white women, is higher than can be statistically ignored. The extent of which the android pelvis is incriminated in the etiology of persistent occipito-posterior positions is shown by statistical studies. This pelvic form is also responsible for the poorer prognosis for spontaneous delivery in the otherwise excellent Bantu parturients.

b) The head form of low cephalic index exerts an important influence on the course of labour in occipito-posterior positions. By increasing the length of the occipital lever relative to the frontal lever, it becomes a potent factor promoting extension of the foetal head in labour. The cephalic index of the full term Bantu foetus is in the lower limits of the range which

anthropologists, in their studies, have come to accept as normal. By contrast the Cape Coloured full term foetus has a higher cephalic index - near the upper limits of this range, and the difference between the two groups studied is of an order which on statistical analysis is greater than can be accounted for by chance, indicating therefore, that systematic causes are responsible for the difference. (Appendix II.)

c) Cranial form must be considered in conjunction with pelvic architecture. It is a combination of these two factors which is responsible for extension of the foetal head in labour, provided the head is slightly deflexed at the onset of parturition, for neither cranial or pelvic morphology have any effect

on the completely flexed head.

d) When the above-mentioned factors are present the persistent occipito-posterior position must be considered a physiological adjustment of the foetal head to the type of pelvis. The posterior mechanism must be regarded as an obligatory rather than an accidental one. This mechanism is only necessary when the foetal cranial dimensions of importance in labour (depending on the degree of extension) approximate the available pelvic dimensions in magnitude. Extention of a small and easily mouldable head (as in a premature labour) in a capacious pelvis has not the same effect on the course and outcome of labour, especially if the pelvis is so completely rounded that all its dimensions are more or less the same. In

this type of case, the foetal head may traverse the whole length of the pelvis without any rotatory mechanism; delivery as an anterior or a posterior is equally possible.

e) Inefficient uterine action of many types may be responsible for arresting the progress of labour. If the occiput is posterior at the onset of parturition, the case presents as a persistent occipito-posterior position after full dilatation.

f) Other factors such as persistent asynclitism, lax perineum, and prolapse of a hand in front of the head, are of doubtful significance. Each may be responsible for the condition in isolated cases.

Management should always be predicated on the accoucheur's concept of the etiology in every case. The realisation that obligatory adaptation between foe-

tal head (in its extended attitude) and maternal pelvic configuration, is necessitated by similarity in size and capacity, respectively and that the persistent occipito-posterior position is often physiological, should increase our equanimity in managing these cases and lay the emphasis on logical conservatism.

APPENDIX ONE.

A STUDY IN BANTU PELVIC MORPHOLOGY.

A STUDY IN BANTU PELVIC MORPHOLOGY.

There is considerable conflict of opinion as to what factors determine the shape of the pelvis. Caldwell, Moloy and D'Esopo[38] are of the opinion that the shape of the pelvis is determined by two distinct and radically different factors, the first being an evolutionary influence and the second a hormonal one. Thoms and Nicholson[39] believe that nutrition, in the growth period, has a profound influence on pelvic form. (A discussion of the conflicting and controversial views concerning the evolution of pelvic shape will serve no purpose; in any case the point is not really germaine to the subject of this work.)

Caldwell and Moloy developed the precision stereoscope which enabled them by visual means to classify the true shape of the pelvic inlet and study the cephalopelvic relationships in three dimensions. Other workers have followed this method of visual interpretation of shape by use of precision stereoscopy. Different observers viewing the same inlet will often disagree as to the shape because there is no definite criterion by which the shape can be defined. The pioneers in this field of work recognised the difficulty and Caldwell and Moloy[40] (1934) records that "even an inexperienced observer will encounter little difficulty in recognizing examples of the parent types, the gynaecoid, android, anthropoid or

flat forms. The intermediate forms may however afford difficulty unless their anatomical relationships to the parent types and a general conception of the factors which bring about the diversity of form observed in living women are clearly understood." Whilst Berman[41] (1953) states " essentially it is merely a matter of subjective impression and , as such, completely dependent on the personal equation" It is shown by experimentation that the same observer may refute his earlier findings as to the interpretation of shape on different occasions. Different observers may disagree to such extent the results are completely unreliable. Unless a consistant and uniform interpretation of pelvic inlet shape is attainable, it is clear that any classification that depends on subjective impressions has serious drawbacks. Statistical reports dealing with the percentage of incidence of the various pelvic types of the Caldwell - Moloy classification, show marked differences, which may possibly be explained by variations in the population, depending on geographic and racial distribution but in assessing statistical differences in racial groups, errors in defining the cardinal diameters, technique of film production and differences in the method used for the correction of X-ray distortion, must always be borne in mind.

METHOD AND NATURE OF DATA COLLECTED.

The radiological survey was conducted in the following way. Every primigravida, attending the pelvic assessment clinic at the Somerset Hospital, had an X-ray pelvimetry regardless of the clinical findings, that is to say, whether the head was engaged or not. All primiparae are told to attend this clinic after the thirty-seventh week of gestation. Multiparae could not be included in this study because a fair proportion of the "booked" multigravidae are accepted for hospital delivery on account of their poor obstetrical histories. The inclusion of these cases would have vitiated the results of the survey because their pelves, in some cases, had already been tried and found wanting.

Care was exercised in the racial selection of material; only those cases in which the identity of the race of the individual was indisputable were included in the series. The detailed identification of material was along the lines described in the section dealing with craniometrical studies (Appendix 2, page I62) Nearly all patients belonged to the Xosa and Zulu tribes. The tribal numbers in the series were as follows:-

I.	Xosa	I9I.
2.	Zulu	76.
3.	Fingo	38.

Three hundred and sixteen patients were X-rayed. In eleven instances the X-rays were not completely satisfactory.

These included cases in which the end-points for the cardinal diameters were not clearly definable, as well as plates which were poor because of the positioning of the patient, as evidenced by the obturator foramina being visible in the inlet view, or the femora not being opposed in the lateral view. Thus from the inlet, lateral and outlet views, a decision was made, classifying the pelvis under one of Caldwell and Maloy's fourteen possible types. To lend to the survey a greater objective significance, the subpubic angle, brim index and interspinous diameter, were also calculated.

The method of pelvimetry used was that which employs the principle of similar triangles as a means of correcting for X-ray distortion. Albert (1897), in Germany, is credited with being the first to study the female pelvis by X-rays. Two years after the monumental discovery by Roentgen, Albert utilized the symphysis to determine the object-film distance for measuring the inlet diameter. Berman[42] (1955) states "it is remarkable, in the light of our present knowledge, how accurate and how astute Albert was, and how his approach to X-ray pelvimetry has stood the test of time". Also in 1897 two Frenchmen, Budin and Varnier, working independently also used X-rays to study the inlet.

THE TRANSVERSE AND BI-ISCHIAL-SPINOUS DIAMETERS.

The transverse and bi-ischial-spinous (or, simply 'bi-spinous') distance are obtained from a simple antero-posterior view with the patient lying supine for practical purposes the height of the transverse diameter of the pelvic inlet is assumed to lie at $\frac{2}{3}$ x (pubis-table top distance); the bispinous diameter is regarded as lying at $\frac{I}{3}$ x (pubis-table top distance). Correction will be accurate to O.I inch or less (McLaren and Hartley)

The alternate method of obtaining the correction factor for the geometrically magnified transverse diameter is ingenious but cumbersome. The lateral view is used in this method. The location of the inlet transverse diameter is found by drawing a line parallel to the cord of the sacrum from the ischial spines to the inlet antero-posterior diameter (drawn in on the film.) Its distance from the table top can now be measured and corrected by the nomogram (Ball or Schwarts method). Similarly, the distance of the interspinous diameter, from the inlet, can readily be calculated, corrected and substituted in the appropriate formula to obtain the answer.

The antero-posterior diameter was calculated from the lateral view film in every case in the present series. This method is considered preferable to using the inlet view because the end points are more clearly

defined and X-ray measurements more accurate from the lateral view film.

RESULTS AND COMPARISON.

The results of the radiological investigation into Bantu pelvic morphology are recorded in the following tables. The figures of Caldwell-Moloy, Kenny and Heyns are given for comparison. Before proceeding to analyse the figures in table (A) it is necessary to briefly comment on pelvic classifications. Since X-ray films of the pelvis are essential for the Caldwell-Moloy classification, it cannot be used for typing the pelvis by any other means. The point is important because many clinics are using the Caldwell-Moloy classification and the terminology without the use of X-ray pelvimetry . In other words an attempt is made to use an X-ray classification for clinical and other non-radiological methods. "By such use, there is no doubt that many erroneous and misleading conclusions are reached. Since this classification is based on inlet shape alone, it is obvious that any attempt to apply it clinically is merely guess-work" (Berman 1955.) Furthermore, it is difficult to classify the inlet even when X-rays are available. There is so little variation between many of the fourteen different types that accurate classification is most uncertain. The criteria, distinguishing one type from another, are vague and indefinite. Berman.)

Reference must also be made to the fact that the figures of Heyns are based on a study of dry pelves. This must be borne in mind in analysing the figures. Whether the Caldwell-Moloy classification and the terminology is applicable to this mode of study, in a manner strictly comparable to their radiological values, is difficult to determine.

The first observation to be made from table I5 is the low incidence of the true gynaecoid pelvic type in the Bantu. The figure for the'dry pelves series' (28.4%) as well as that obtained from the radiological investigation (25.2 per cent) are both appreciably lower than any figures recorded in the literature. This is the fundamental point of difference between the results obtained by Caldwell and Maloy in 2I5 primigravid white American women and the two forms of study in the Bantu.

Caldwell and Moloy directed attention to the posterior segment of the inlet in their classification which has since been universally adopted. If we follow their methods and type pelves mainly on the shape of this posterior segment then the following results emerge. Gynaecoid, gynaecoid-anthropoid, gynaecoid- android and gynaecoid-platypelloid pelves together constitute 58.5 per cent in their series; the figure for Heyn's series is 52.3 whereas in the present studies the overall figure for all gynaecoid forms is only 45.8 per cent. If we subject

these figures to the conventional formula, according to ordinary statistical principles, the standard error for the difference between the Caldwell-Moloy study and my own is found to be

$$\sqrt{\frac{58.5 \times 41.5}{215} + \frac{45.8 \times 54.2}{306}} = 4.404$$

Therefore the percentage difference is 12.7 ± 4.404 which is 2.883 times the standard error for these series; this is of statistical significance.

If the formula is applied only to the pure gynaecoid form then the percentage difference (for the same two series) is found to be 14.3 ± 4.156 which is 3.442 times the standard error.

Heyns in his investigations obtained figures which on statistical analysis were found to be not materially different from those of Caldwell and Moloy. The only difference being in the proportions of true gynaecoid forms, namely 39.5 and 28.4 per cent, figures, which although they are statistically significant in their difference, were ignored by Heyns in his original study for, as he pointed out, there was no real difference between the percentages for all gynaecoid forms (58.5 and 52.3 per cent.)

A further analysis of my figures shows the prominence of android forms (android, android-gynaecoid, android-anthropoid and android-platypelloid) constituting

34.76 per cent of all types whereas the corresponding figures are Caldwell and Moloy 22.2 per cent and Heyns 19.5 per cent. Statistical analysis shows that the standard error in comparing the 215 American White and 305 Bantu women is 3.929. The percentage difference for the android forms is 12.5 ± 3.929 per cent which is 3.181 times the standard error. Statistically, therefore, this difference cannot be ignored. Heyns figure for this group analysis is the lowest of the three, but the difference is not statistically significant when compared with the Caldwell-Moloy series.

If we analyse the findings in the different investigations on a broader basis and select only pelves showing an android tendency - whether it be in the fore pelvis or the hind pelvis - the following figures are obtained. Android, android-gynaecoid, android-anthropoid, gynaecoid-android and android-platypelloid pelves constitute 46.8 per cent in the radiological study of the Bantu womens series and only 33.3 in the Caldwell-Moloy group. The percentage difference of 13.5 ± 4.297 is 3.142 times the standard error. This again is statistically significant. Heyns figures show almost exact agreement with those of the American workers in this respect.

The android tendency in Bantu pelvic morphology brought out by these figures, is not surprising. It is in keeping with our clinical observations on the general build of so many of our Bantu parturients. Early attempts,

his radiological studies. His figures are slightly higher than that obtained by Ince and Young ("London Women") in over 850 cases (Rural English 88.3 London English 90.80 ± 0.36) but no significance can be attached to the difference.

The work of Ince and Young in London, and Nicholson in Gloucestershire suggests that there is no correlation between the shape of the inlet, and the outlet. They, for example, found no relationship between the length of the posterior sagittal diameter at the brim and the subpubic angle - in other words, a pelvis with a narrow posterior segment did not necessarily have a narrow subpubic angle, a feature of the android pelvis which occurs so frequently in the Caldwell-Moloy series. Attention has been directed to the subpubic angle in the study of the Bantu pelvis not to prove or disprove Caldwell and Moloy's conception but because of the clinical impression that the Bantu woman more commonly has a narrow subpubic arch than other parturients.

The subpubic arch has been described clinically and by X-rays at length in general terms. It is classified as average, narrow and wide; such terminology is largely dependent upon the subjective impressions of the examiner. This applies to manual palpation as well as to X-ray interpretation of the outlet. The subpubic arch or subpubic space is very irregular and difficult to describe. It shows considerable variation and has certain correlation

as, for example, those by Greulich and Thoms (1939), to discover a relationship between body build and type or capacity of pelvis, were at first devoid of success. Thus it is written that women in whom the shape and size of the pelvic inlet were identical, resembled one another "closely, slightly or not at all in general appearance and in external bodily dimensions". Later observations by Nicholson (1945) emphasized a correlation between pelvic form and body build.

Caldwell, Moloy and D'Esopo in their later writings stress the correlation between pelvic type and physical form - as does the most recent literature. They state that the woman with an android pelvis presents a characteristic picture from the posterior aspect which produces a "..... square bodily appearance in relation to shoulders, waist-line and hips. There is a tendency for the thick set, short individuals to predominate, although tall muscular heavy-boned types are favoured. The lower legs are thick and straight throughout. In the gynaecoid type the thickness of the thighs ceases at the knees, but in the android type this thickness continues into the calves, the ankles and the feet". This description aptly fits so many of our Bantu patients. Reference has already been made to the frequency with which the masculine types are seen, in an earlie section of this work. It may be reiterated here that Donald remarks on the smallness of the cervix and the skimpiness of the dimensions of the vaginal vault in subjects of this

android type. These features are also frequently observed in our Bantu parturients. The strong android tendency in their pelvic morphology is therefore not surprising.

One of the main objections to the classification of Caldwell and Moloy is that it appears to be based purely on visual impressions. They give no indication that measurement plays a role in deciding to which group a pelvis belongs. The classification is moreover a complicated one - 'sufficiently complicated to be poorly understood' (Heyns). It is well known that visual impressions vary from observer to observer, so that universal use of this classification cannot be reliable.

To lend to the radiological study, of the Bantu pelvis, a greater objective value than could be achieved by visual classification of inlet shape, the Brim Index and the subpubic angle were calculated in each case. The Brim Index reflects a pelvic shape in a limited way. Its chief merit lies in the fact that the personal equation does not enter into the computation. The control group in the series was composed of one hundred Coloured primiparae who had X-ray pelvimetries antenatally. The results are recorded in table I6, from which it is clearly seen that no statistical import can be attached to the difference in the two groups. Heyns in his investigations (65 dry pelves and I00 antenatal primigravidae) found an average index of 90.35 $\pm$ I.02 in the dry pelves series and 93.60 $\pm$ 0.72 in

his radiological studies. His figures are slightly higher than that obtained by Ince and Young ("London Women") in over 850 cases (Rural English 88.3 London English 90.80 ± 0.36) but no significance can be attached to the difference.

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with male and female characteristics from an anthropological point of view. Berman states that the sex may be recognised, by the anthropologist, from the type of pubic arch if only the bony pelvis is available. He is overstating the case of sex differences in pelvic morphology. Elliot Smith and Wood Jones, during their excavations in Nubia, recognised a number of female pelves which so closely approached the form of the male that the presence of foetal bones in the pelvis alone suggested the true sex of the skeletons.

To provide a more accurate and objective means of classifying the pubic arch, the outlet angle has been described. It is formed by joining the lower border of the symphysis pubis to each tuberosity. The angle which is formed can be measured accurately by a protractor and the results are consistent. They can be duplicated by others since definite end-points are used. Each pelvis has one definite outlet angle which can be reproduced consistantly if the same positioning technique is used. The average or normal outlet angle measures eighty-five to ninety degrees. Angles below eighty degrees are classified as narrow; angles greater than ninety degrees are classified as wide. Changes in the positioning of the patient and the location of the tube and its degree of angulation will produce small variations of the outlet angle.

The results of the study of the subpubic angle recorded in table I7 show that 39 per cent of Bantu

TABLE I5.

DISTRIBUTION OF PELVIC TYPES (CALDWELL-MOLOY CLASSIFICATION.)

PELVIC TYPE.	AMERICAN	ENGLISH.	B A N T U.	
			Dry Specimens.	Radiological Study.
Gynaecoid.	39.5 (85)	34.8 (348)	28.4 (I9)	25.2 (77)
Android.	II.6 (25)	20.3 (203)	9.0 (6)	I7.7 (54)
Anthropoid.	II.6 (25)	6.4 (64)	I3.4 (9)	I2.7 (39)
Platypelloid.	0.9 (2)	I.5 (I8)	I.5 (I)	I.3 (4)
Gynaecoid-Anthropoid.	4.6 (I0)		6.0 (4)	4.9 (I5)
Gynaecoid-Android.	II.I (24)	II.0 (II0)	II.9 (8)	II.I (34)
Gynaecoid Platypelloid	3.3 (7)		6.0 (4)	4.55 (I3)
Android-Anthropoid.	3.7 (8)		6.0 (4)	4.55 (I3)
Android-Gynaecoid.	5.I (II)	25.I (25I)	I.5 (I)	9.5 (29)
Android-Platypelloid.	I.8 (4)		3.0 (6)	2.9 (9)
Anthropoid-Gynaecoid.	6.5 (I4)		II.9 (8)	3.9 (I2)
Assymmetrical Forms.	I.8 (4)	0.6 (6)	I.5 (I)	I.9 (5)

primigravidae have a subpubic angle below 80° whereas only 22 · per cent of the control coloured group fell in this category. The percentage difference of I7· ± 5.007 is 3.394 times the standard error and therefore statistically significant.

The gynaecoid pelvic group shows a decided preference for average or wide subpubic angles (Caldwell and Moloy.) The android group shows a very definite tendency to the narrow forms. More important is the marked relationship between the width of the arch and, the splay of the sidewalls of the pelvis, 'narrow arches being associated with converging side walls in IOO per cent of the cases studied' (Caldwell, Moloy.)

In conclusion it may be stated that the radiological study of Bantu pelvic morphology revealed no startling differences as compared with studies in England and America. In regard to the classification of pelvic types the pure gynaecoid form is seen less frequently than in Europeans and White Americans; according to the results of this study the android form and those pelves showing an android tendency are significantly more frequently encountered in the Bantu. Studies of the Brim Index yielded no information than that already known. On the whole the Bantu parturient has a narrower subpubic angle than that which obstetric opinion has come to accept as average.

American figures; Caldwell,W.E., and Moloy,H.E., Am. J. Obst and Gynae 28: 482, I934

Dry Pelves: Heyns, O.S., J. Obstet. Gynae. Brit. Emp., 53, 243.

English figures: Kenny, Meame (I944) J. Obstet. Gynae. Brit. Emp. 5I, 277.

TABLE I6.

RACE	BRIM INDEX	INTERSPINOUS DIAMETER
BANTU	92.3	10.2
COLOURED	90.2	10.6.

SUBPUBIC ANGLE

TABLE I7.

RACE	TOTAL	% WITH SUBPUBIC ANGLE BELOW 80
BANTU	305	39
COLOURED	I00	22

APPENDIX TWO.

COMPARATIVE CRANIAL MORPHOLOGY.

COMPARATIVE CRANIAL MORPHOLOGY.

1. Introduction.

2. Evolution of Skull and variation of Cephalic Index in different Ethnic and Racial groups.

3. The Cephalic Index in the newborn, the influence of age.

4. The calculation of the Cephalic Index in the term foetus based on Empiric formulae developed by graphic methods, the method of averages and the method of least squares.

5. Assessment of certain cranial dimensions by mensuration and by radiological methods, on the unmoulded head of the newborn infant.

    1) Selection of material.

    2) Methods of assessment.

    3) Results, Comparisons, Conclusions.

INTRODUCTION.

While a historical account of the development of the comparative study of skulls is beyond the scope of this work, it is of interest to note that the subject was dealt with, by Versalius, as early as the sixteenth century. In more recent times descriptive craniology has been largely supplemented by craniometry. Nevertheless, certain observers who have achieved no little notoriety in this field, have almost absolutely rejected numerical or craniometrical methods. Chief amongst them is the Italian Sergi, who has elaborated a system devised originally by Von Baer[44] at Göttingen at the beginning of the nineteenth century, but Sergi carried the purely descriptive method to such an extreme as renders its use almost impractical, owing to the minuteness of detail which suffices for the creation of new specific cranial types and their consequent multiplication.

In the study of cephalometry which consists essentially in supplementing descriptive by numerical data, we find at once several distinct groups of matters which claim attention. The first concerns the question of moulding. In nearly all primigravid deliveries moulding is gross enough to be easily discernible; the same applies to a small number of multigravid labours. There remains the group in which inspection of the newborn infants skull

reveals no overt evidence of moulding. To what extent is one justified in placing reliance on this visual evidence? Thus the statement recurs in the literature on cephalometry, that cases were selected in which moulding was not discernible. If these studies are to have their full value, then only those cases in which moulding could not have occurred, should be used in these investigations.

A second tenet of the same problem is the time after delivery at which the measurements are carried out. When the head is measured at birth and again 24 hours later, it is usual to find that the bi-parietal diameter has increased by one or two millimetres (Moir[44] 1946.) Sometimes the difference may be four or five millimetres or even more but in these cases the head is less well ossified than normal, and can be readily altered even by finger pressure (Moir.) This rapid increase in this dimension is merely the restoration to its immediate antepartum or pre-moulding magnitude. Mensuration 48 to 60 hours after delivery would yeild more accurate results. This point is referred to later in this work.

A second problem was the choice of measurement to be studied. From the obstetric point of view the occipito-frontal diameter is of greater practical significance than the slightly different Inion-glabella

dimension, the latter being of anthropometric importance; however, it is the latter diameter which has been most extensively investigated. My own studies were confined to the Inion-glabella measurement because of the paucity of detailed literature on the occipito-frontal diameter.

While craniometric studies have been conducted on nearly every major race, the literature is strangely deficient in accurate investigations on the unmoulded newborn infants head. Variations in the different anthropometric cranial and facial indices have been shown to exist between different racial groups, but the same differences have never been scientifically proven to exist in the newborn of these same groups. The assumption that these differences are present at birth in some degree is untenable, because it is known that the face and the skull undergo extensive postnatal development. In what is to follow a brief account will be given therefore of the prenatal and postnatal development of the skull.

EVOLUTION OF SKULL AND VARIATION OF CEPHALIC INDEX IN DIFFERENT ETHNIC AND RACIAL GROUPS.

Anthropologists appealed to the embryological history of man in their search for evidence indicative of

the precise path traversed by his ancestors in the evolutionary progress towards the human stage and from embryology the evidence forthcoming, while it indicates what may be termed an ape stage as marking an epoch in that progress, has not yet provided more exact details than such, for example, as suggest that the history runs for a longer period with that of the Simiidae than of the Cercopithecidae. But no single example among the larger Simiidae can be pointed out with confidence as embodying the characters of the human ancestor at the Simian stage of evolution. More completely than any other though, there is a slight margin of evidence in favour of the chimpanzee,[46] rather than the gorilla or orang-utan. We must acquiesce in what is admittedly a somewhat disappointing result and await the acquisition of more delicate means of analysis and observation applicable to embryological study.

Of the remaining lines of investigation that which treats of anatomical variations and departures from the nodal type, was shown to be appropriately divisible into two sections. The first of these indicated the general evidence for the occurrence in human morphology of variations to which an atavistic significance may reasonably be attached. The second section relates to

the comparison of human races with the object of ascertaining whether Simian characters are present in any particular race more numerously or in higher degree than another.

Comparison of human skulls is greatly facilitated by the computation of certain indices, of which the cephalic index reflects on the ratio of length to breadth. Unfortunately this breadth or cephalic index is not applicable to the skulls of the Simiidae with results strictly comparable to those obtained from human skulls;(for in the Simiidae bony ridges modify the form of the cranial bones to a considerable degree) but there is a certain indication that the skulls of the orang-utan tend towards the Brachycephalic, those of the gorilla to the Dolichocephalic category (and the latter are associated with many examples of cercopithecidae), while the chimpanzee may be considered to represent the intermediate group. Thus taken by itself no absolute indication of morphological inferiority is provided by a low, moderate or high figure representative of the Breadth Index.

The chief modifying influences may be summed up as being age, race, and sex. The skull form in the prenatal period tends on the whole to Brachycephaly and a comparison of Frorieps figures for this index in skulls of

infants and adults in the Würtemberg collection points to the same conclusion. In regard to the influence of sex good examples are to be found in certain Australian and South African ethnic groups; the female skulls are more mesaticephalic, the male crania are dolichocephalic. From the literature there appears to be no doubt that in the darkly coloured races the predominant form is dolichocephaty though at the same time this characteristic is found in certain white stocks inferior to none in intellectual ability. A table compiled by Deniker gives the following figures as representing the extremes of variation of the average cephalic index in adult human skulls.

73 Fijians : Cephalic index - 67.2

41 Lapps : " " - 85.6

A survey was conducted by Morris Steggerda in 1940 on the females of the Navajo tribe, Negroes and also native-born White stock who claimed Europe as the home of their ancestors. Any Navajos who were aware of White Negro or other Indian mixture were excluded from the study. The Negroes were selected so as to eliminate any Negro-White hybrids. Thus any individual with fair skin or soft hair was omitted. He came to the conclusion that the Navajos are very brachycephalic. In absolute measurements

they have much shorter and broader heads than other races, resulting in a high cephalic index, namely 85 per cent. The Negroes, whose ancestral home is Africa, are dolichocephalic having an index of 76 per cent. The whites are intermediate, with an index of 78.5 per cent.

A. Dionisio Barreto, working in Mozambique, investigated the cephalic (and nasal) indices in both males and females of the Ba-chopi, Ba-rouga and Shangaan tribes. His results are recorded in the following table. The preponderance of dolichocephaly of the higher grades is strikingly brought out by this statistical study.

DEFINITION OF THE TERM BANTU.

Race to the anthropologist is a purely physical concept. To define race is to characterise a group of men from the standpoint of their common hereditary physical traits. Race, therefore, is inherited breed, or more fully, race is a subdivision of mankind having certain inborn physical traits in common.

The classification of modern races has not yet reached finality, a possible reason for this is that they have diverged from a comparatively recent ancestor. The simplest classification recognises the following main

TABLE I9 CEPHALIC INDEX OF MOCAMBIQUE TRIBES.

	BA-CHOPI				BA-RONGA				SHANGAAN			
	Male		Female		Male		Female		Male		Female	
No. of Cases.	67 Cases.		I05 Cases.		24 Cases		60 Cases		99 Cases		I97 Cases	
Ultradolichocephalic.	58	86.5%	95	90.5%	I6	66.7%	45	75.0%	63	63.6%	II6	58.8%
Hyperdolichocephalic.	5	7.5%	7	6.7%	5	20.8%	II	I8.4%	24	24.3%	54	27.4%
Dolichocephalic.	3	4.5%	3	2.8%	3	I2.5%	2	3.3%	I0	I0.I%	I8	9.0%
Subdolichocephalic.	I	I.5%	-	-	-	-	2	3.3%	2	2.0%	5	2.5%
Mesaticephalic.	-	-	-	-	-	-	-	-	-	-	4	2.3%
T O T A L S.	67	I00	I05	I00	24	I00	60	I00	99	I00	I97	I00

"Contribution to the study of the Cephalic and Nasal Indices of Mozambique Natives." A. Dionisio Barreto. (S.A. Journal of Science - Aug., I955. Vol 52 No.I.

races. Australoids, Negroes and Negroids, Mongolians and Mongoloids, Mediterraneans, Nordics and, Alpine. More elaborate classifications have been propounded, notably by Deniker, who makes out six main groups which he divides and subdivides, arriving ultimately at twenty-nine races or sub-races. Such classifications are bound to be scholastic rather than genealogical.[50] For the purpose of this work it is best to adhere to the genealogical scheme which after all lays no claim to finality.

Negroes and Negroids may be divided into two large groups :-

1) Oceanic Negroes : Papuans, Melanesians in part, Tasmanians, Negritoes.

2) The African Negroes : Negrilloes and Bushmen.

African Negroes may be divided in turn into two main subgroups : The Sudanese Negro and the Bantu, Negrilloes, Bushmen and Hottentots. We are concerned here primarily with the Bantu. In ethnology the only intelligible definition[51] of a Bantu is a full-blood or a half-brood Negro of Bantu speech; and from the physical standpoint no very hard and fast line can be drawn between the northern

Sudanese and southern Bantu groups, considered as two ethnical units. The main body of Negroes is often referred to as the Bantu - a linguistic term which should never have applied to race: (Hocart.)

The Bantu group consists of several divisions among which the Ama-Zula and the Ama-Xosa are in some respects the most remarkable ethnical group in all Bantuland. Indeed they are by common consent regarded as Bantus in a pre-eminent sense, and this conventional term Bantu itself is taken from their typical Bantu language. Aba is one of the numerous personal prefixes, each with its corresponding singular form. Thus aba, ab, and ba are written and pronounced umu, um and mu, in the singular, so that umu - tu and um - utu (a man, a person) becomes aba - utu, ab - utu and bantu in the plural.

There is a clear evidence that the Zulu-Xosas are comparatively recent arrivals, necessarily from the north, in their present territory, which was still occupied by Hottentot and Bushman tribes, probably within the last thousand years or so.[52] Before the Kaffir wars with the English (18II - 77) this territory extended much farther around the coast than at present and for many years the Great Kei River formed the frontier between the white settlement and the Xosas. But what they have lost

in this direction the Zulu-Xosas, or at least the Zulus, recovered a hundred fold by their expansion northwards during the nineteenth century.

Nowhere have patriarchal institutions been more highly developed than among the Zulu Xosas, all of whom, except perhaps the Ama-Fingus, claim direct descent from some eponymous hero or mythical founder of the tribe thus in the national traditions Chaka was seventh in descent from the legendary chief Zulu. Once supremacy and prestige of Chaka's tribe were established, all the others as they were successively reduced, claimed also to be true Zulus,and as the process went on in the far north the term Zulu came to imply in many cases a political rather than a blood relationship.

So also most of the Southern section claim as their founder a certain Xosa, sprung from Zuide who may have flourished about 1500 and whom the Ama-Tembus and the Ama-Mpondos also regard as their progenitor.

But all, both northern Zulus and southern Xosas, are essentially one people in speech, physique, usages and social institutions. The physical features of the Zulu-Xosa are too well known to bear repetition here. It suffices to mention only that their heads are long and

narrow, the cephalic index being 72.5. Keen gives an Index of 71.6.

It is upon the newborn of this distinct group of people that my own studies were conducted. It is therefore the study of the inherited cranial form at birth in a group in which dolichocephaly is a characteristic and marked feature. Unlike the studies of some workers it is not the relationship between the cranial form in the newborn and individual variations in parental cranial morphology which was studied, but an attempt to assess to what extent a racial trait is present in the term foetus of these people.

THE DEVELOPMENTAL CURVE OF HEAD LENGTH/HEAD BREADTH RATIO.

The curve showing the changes of ratio of head height/head breadth with age is an extraordinarily complicated one. Starting at the middle of the gestation period at about 90 per cent the curve descends rapidly to between 70 and 85 per cent at birth (Davenport.)[55] That is to say, during the latter part of gestation the head tends to become more elongated. Davenport suggests that this is

probably an adaptation to the form of the birth canal and serves to "fit the head to that canal in the commonest mode of presentation." Obstetricians will find difficulty in agreeing with Davenport. The fully flexed foetal head may be looked upon as a circle measuring approximately 9.5 centimetres in diameter at its maximal dimensions or in the section taken at the sight of cranial contact. In a normal labour cranial form will play no role in determining the rotatory movements executed by the foetal head. Nor is it conceivable how a low head length/head breadth ratio will alter the sectional shape at the site of cranial contact. If we direct our attention to the deflexed head, then the position of the head at any given moment will be determined by the pelvic morphology, provided there is a similarity in magnitude between the available pelvic diameters and the cranial dimensions of importance in the mechanism of the extended head. The statement does not apply to a large pelvis and a small foetus or to cases of gross disproportion.

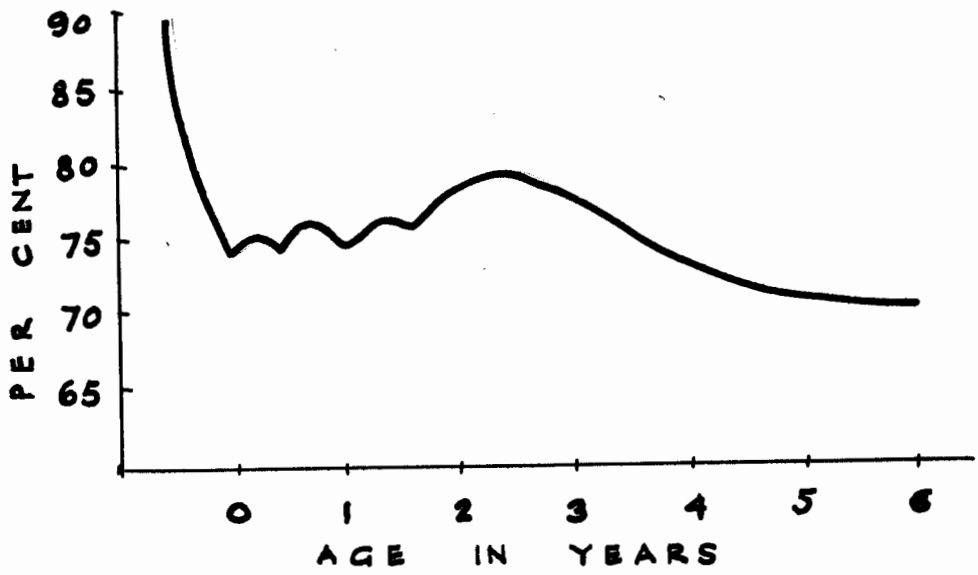
The belief that the pelvic form influences cranial morphology is incorrect. In several personal communications obstetricians expressed the possibility that the Bantu parturient often has a dolichopellic pelvis and that the infants head becomes moulded to this form in labour,

an effect which, they say, persists in later years and which is manifest in the marked dolichocephaly seen in Bantu children. There is a rapid restoration of the cranial shape to its pre-moulding or immediate antepartum proportions very shortly after delivery - a fact which can be shown both by direct measurement and radiologically within 24 to 60 hours after birth.

Immediately after birth the cephalic index rebounds to near 80 per cent on the average, but this ratio ceases to increase at about six months and is followed by a marked decrease "probably due to the action of gravity on the sitting infant." (Davenport)[55] Thereafter at about ten months the head has returned to proportions which are determined by genetic influences. After a year postpartum for some three years the head becomes progressively longer. The varying head length/head breadth ratio plotted against time is shown in the graph below. It is reproduced from Davenport's original paper.

THE CEPHALIC INDEX IN THE NEWBORN INFANT.

There is an extensive literature on the dimensions of the newborn infants head. Most investigators, while appreciating the extent to which the birth process



modifies the cranial dimensions, have made some effort to avoid inaccurate results by selecting for study only those heads in which moulding was not detectable. Nonetheless these cases were delivered vaginally so that the possibility of some distortion by labours was always present. The occipito-frontal diameter is particularly influenced by the course of labour, but there appears to be a lack of unanimity of opinion in regard to the exact way in which it is altered. The cranial distortion resulting from the birth process is determined by the position and attitude of the head thus the head which is extended in the occipito-posterior position, so that the greatest diameter is the occipito-frontal, undergoes a distinct type of moulding

originally described by Baudelocque and Hodge. This type of moulding is very much different from that seen when the head is occipito-posterior in position but fully flexed. It is submitted that too little attention has been paid to the position and attitude of the head in assessing the effects of moulding.

According to Scammon and Calkins[56] birth moulding causes a decrease in the occipito-frontal diameter. This is shown by the values of this dimension at 50 centimeter Crown-Heel length in different types of material which are fresh specimens II.40 cm, living unmoulded heads 12.10 cm, injected and preserved specimens II.40 cm. These figures indicate that this dimension is decreased apparently one centimeter during birth, state these authors.

There are other factors which modify the results in craniometrical studies. These must be mentioned because at the end of this section a comparison will be made between my own findings and those of other workers. The mechanical error of determination is quite small for the end points are definite bony landmarks. Injection increases this diameter about 2.5 per cent. Subsequent immersion in formalin increases it still more in the first month but thereafter, there is a gradual decrease and at the end of six months preservation a correction of -2.5 per

cent will approximate the value for fresh material. Formalin preservation without injection, apparently does not affect this dimension (Scammon and Calkins.)[57]

The growth of the occipito-frontal dimension of the foetus has been studied by Caspar, Spondi, Ribemont, Depaul, Solares, Lafaille, Weiss, Corrado, Hauser, Kjolseth, Friedenthal and others. The findings of these workers are summarised in the following table (table 20). These figures were obtained from Scammon and Calkin's monograph entitled "Growth in the foetal period." No information is available concerning the nature of material selected for study, that is whether fresh, unmoulded or injected material was used.

THE BIPARIETAL DIAMETER.

The biparietal diameter is distinctly, affected by birth moulding. The values of this dimension at 50.0 centimeters crown-heel length in three types of material studied are as follows :-

1) Fresh Specimens	8.77	centimeters
2) Living unmoulded heads	9.60	"
3) Preserved Specimens	9.10	"

TABLE 20.

THE OCCIPITO-FRONTAL DIAMETER AS OBTAINED BY DIFFERENT WORKERS.

A U T H O R.	CROWN-HEEL RANGE (CENTIMETERS.)	
	45 - 50	50 - 55.
Caspar I854	I0.8, 48.2, (I06)	II.I, 52.4, (70)
Spondi I857	II.8, 47.8, (74)	I2.2, 52.3, (6)
Ribemont I879	II.44, 47.2, (I04)	II.9, 5I.7, (8I)
Depaul I879	II.5, 48.2, (98)	II.9, 50.9, (I02)
Solares I88I	II.5, 48.3, (40)	II.9, 5I.0, (57)
Lafaille I893	II.4, 47.5, (70)	II.7, 50.9, (64)
Weisz I897	I0.85, 47.0, (?)	II.4, 50.0, (?)
Corrado I899	I0.30, 47.4, (52)	II.4, 5I.8, (80)
Heuser I9I2	II.05, 48.2, (8)	II.3, 50.5, (4I)
Kjölseth I9I3	II.5, 48.2, (?)	I2.I, 5I.I, (?)
Friedenthal I9I4	I2.6, 47.0, (I)	I2.6, 50.I, (I)

The first figure in each square represents the occipito-frontal dimension in centimeters. Figures in parenthesis indicate the number of cases. The other figure represents the average crown-heel length for each series.

From these figures it appears that the biparietal diameter is reduced by 8.3 millimeters in labour (Scammon and Calkins.)[58] The computed reduction in certain cranial dimensions is referred to at a later point in this section. The following table is a summary of the published observations on the biparietal diameter. (Table 2I)

Craniometrical studies in the newborn are influenced to an appreciable degree by the presence or absence of moulding. In most cases the infants head becomes more brachycephalic in the first month of life, suggesting that the general result of parturition is to "impress dolichocephalic properties temporarily on the skull." (Duckworth)[59] This is undoubtedly true for the majority of cases. The veracity of the assertion is also reflected in Davenport's graph on the changing cephalic index both antenatally and in the immediate postnatal period. The findings of Scammon and Calkins are in conformance with this view. In their monograph they conclude that the occipito-frontal diameter is reduced by one centimeter whereas the biparietal reduction was 8.3. millimeters. Expressed in a different way : the occipito-frontal reduction is equal to one twelfth of its length whereas that for the biparietal is one-eleventh of the biparietal dimension. These reductions serve to render the head more elongated.

TABLE 2I.

THE BIPARIETAL DIAMETER AS OBTAINED BY VARIOUS WORKERS.

A U T H O R.	CROWN-HEEL RANGE CENTIMETERS.	
	45–50	50–55
Caspar I854	8.6, 48.0, (I06)	8.5 52.4 (79.)
Spondi I857	8.7, 47.8, (74)	9.I5 52.3 (6)
Sutugin I875	8.8, 47.25,(II6)	9.4 52.0 (4I)
Depaul I879	9.2, 48.2, (98)	9.6 50.9 (I02)
Ribemont I879	9.25, 47.2, (I04)	9.6 5I.7 (8I)
Solares I88I	9.3, 48.3, (40)	9.6 5I.0 (57)
Lafaille I893	9.I, 47.5, (70)	9.5 5I.9 (64)
Weiss I897	8.7, 47.0, (?)	9.I5 50.0 (?)
Cerrado I899	8.5, 47.3, (52)	9.I 5I.8 (80)
Kjolseth I9I3	8.4, 47.0 ,(I)	9.05 50 (I)

The first figure in each square represents the biparietal diameter in centimeters. Figures in parenthesis indicate the number of cases the other figure represents the average crown-heel length for each series.

These calculations are based on the work of Scammon and Calkins who were the first workers to assess the influence of parturition in a scientific manner. Up to that time (1929) the exact nature of moulding had not been investigated in detail, although studies that considered the subject from a qualitative viewpoint had appeared from time to time in the literature. The only work which dealt with the actual amount of change in any given dimension was that of Stampf[60] (1907). This author's study was confined mainly to determine the amount of change in the circumferences of the head in the suboccipito-bregmatic and suboccipito-frontal planes. It was based on some 200 newborn children measured soon after birth and again on the seventh day. These figures were all obtained from living children, none of whom were born by forceps extraction or through contracted pelves and hence were representative of normal cases, rather than abnormal ones such as stillborn children may well be.

In order to arrive as nearly as possible at the exact size and proportions of the foetal skull in utero and at term, Scammon and Calkins made a special series of head measurements of newborn children in which moulding was eliminated. They selected the following two types of cases for the purpose : first, infants born by caesarean

section, without the previous occurrence of labour pains, and second, infants born by breech extraction where this extraction was quickly and easily performed. In connection with the breech infants they state that considerable care in the selection of the latter group (Breeches) was necessary as one will often observe moderate moulding in some breech-born infants.

It is of considerable interest to analyse the work of these two authors. In all, 33 infants were studied; measurements were made on the first day of postnatal life in order that growth changes might not alter the dimensions. Of these children, 5 were premature, according to the menstrual history and the body length, and one was postmature. (These 6 cases were not included in their determinations of the averages for the foetal head at term.)

A study of Table VII compiled by these authors and recorded on page 27 of the first edition of their work, shows that their cases may be divided, conveniently, into four groups.

GROUP I. Palpable moulding (recorded as "slight or very slight" by them) was present in fifteen cases.

These were all breech deliveries. The cephalic index for this group of cases is 80.008 per cent. (The two premature cases are not included in this calculation.

GROUP II The cephalic index of the two premature infants in whom moulding was discernible is 76.7 per cent.

GROUP III No moulding was detected in fifteen full term infants and three premature infants. The cephalic index of the full term infants is 79.6 per cent.

GROUP IV The cephalic index of the unmoulded premature group is 79.8 per cent.

From these observations two conclusions are reached which should influence other workers in their investigations :-

I) The first is that while moulding may be present in easy breech deliveries, it is not of such an order as to influence the computation of the cephalic index in the newborn. Thus fifteen

breeches in whom moulding was detectable at birth had an average cephalic index of 80.006 per cent; the index in fifteen full term infants who showed no moulding was 79.6 per cent. No significance can be attached to the difference.

2) Moulding may significantly alter cranial shape in premature breech-born infants. The cephalic index for this group in the Scammon-Calkins series was 76.7 per cent. The premature breech-born infant therefore is best not included in biometric studies.

Anatomists define the Cephalic Index as the ratio of the greatest width to the length of the skull expressed as a percentage. The greatest width is situated above and behind the external auditory meatuses; the length is determined by measuring the distance between the inion and the glabella. The glabella is defined as the point in the midline between the supraorbital arches. In the only study to date conducted on the Bantu infants head (Heyns)[61] the greatest distance between occipital and frontal bones was measured. The relationship of this diameter to the inion-glabella dimension will be a variable one determined by individual anatomic peculiarities. Most attention has

been focused on the inion-glabella measurement in the literature of the past hundred years. From the obstetrical viewpoint the measurement which is defined as the greatest distance between the occiput and the frontal bones, supersedes the inion-glabella length in importance.

Since my own studies were to be essentially of a comparative nature, I conducted them on the accepted anthropometric dimensions to determine the length-breadth index and so facilitate comparison with workers in other countries.

From tables 2 and 3 the cephalic index can readily be calculated as based on the results of individual worker's investigations. In the following table (table 22) two indices are recorded opposite the name of each worker, the two figures representing the index for different crown-heel measurements. This division based on the total length of the infant was made in order to render my own findings on the Bantu infant comparable in a more accurate manner. In my own series the cases sellected included no premature infants as understood by our accepted obstetric definition, yet the overall (crown-heel) lengths varied considerably.

THE CEPHALIC INDEX IN THE NEWBORN (BASED ON THE MEASUREMENTS OF DIFFERENT WORKERS.)

TABLE 22.

RACE.	CROWN-HEEL RANGE. (m.m.)		AUTHOR.
	450-500	500-550	
Rhenish	79.64 (106)	76.57 (79)	Caspar
German	73.72 (74)	74.99 (6)	Spondi
French	80.85 (164)	80.69 (81)	Ribemont
French	80.00 (98)	80.69 (102)	Depaul
French	80.77 (40)	80.69 (57)	Solares
French	79.82 (70)	81.19 (64)	Lafaille
Greek	82.85 (52)	79.82 (80)	Corrado
Norwegian	73.05 (1)	74.78 (1)	Kjölseth
German	80.15 (?)	80.26 (?)	Weiss

Figures in parenthesis indicate the number of heads measured.

THE CALCULATION OF THE CEPHALIC INDEX IN THE TERM FOETUS BASED ON EMPIRICAL FORMALAE DEVELOPED BY GRAPHIC METHODS, THE METHODS OF AVERAGES AND THE METHOD OF LEAST SQUARES.

The increase in the various external dimensions of the body in the foetal period bears a rectilinear relationship to body length. The relation of these dimensions may therefore be expressed as :

$$D = aL + b. \quad ^{62.}$$

Where D is the dimension, a, is a constant, that may be positive, negative or zero. The formulae for the dimensions of the head are characterised by positive b constant. Therefore, these dimensions are relatively larger in the early part of the foetal period than at its close and, have made a greater amount of growth with respect to body length in the embryonic period than they do in equal later intervals of body length. In such an expression the constant 'a' represents the slope of the line in question and the constant 'b' represents the elevation or depression of this line above the abscissa at its intercept. In other words 'a' represents the absolute rate of growth in the dimension with respect to growth in body-length in the period under consideration, and it may be determined by the expression:

$$\frac{D_2 - D_1}{L_2 - L_1} \qquad 63.$$

Where L_1 and L_2 are any two given successive crown-heel lengths and D_1 and D_2 are values for any given dimension at these lengths.

These relations between the magnitude of the various external bodily dimensions and age or time in the early foetal period have been represented by curves and figures based upon analytic convention expressing the relation of total body length to foetal age.

The growth in total body length with respect to time or age in the foetal period is represented by the parobola :

$$L = 28\sqrt{T - 0.74} - 35 \qquad 64.$$

$$\text{or} \quad T = 2.3 + \frac{2.5\,L}{28} + \frac{L^2}{784}$$

$$\text{or} \quad T + \left(\frac{L}{28} + 1.25\right)^2 + 0.74$$

Where L is the total crown-heel length of the body in centimeters and T is the age in foetal or lunar months. (This formula does not hold good below three months.)

The accuracy of these empirical formulae is best demonstrated by comparing the computed values for occipito-frontal and biparietal diameters with the observed results of workers who have exercised care in their selection of material for study. The following two tables (23 & 24) set out such a comparison, the figures obtained by direct mensuration of selected material being those of Scammon and Calkin. The difference between the results obtained by the two methods have been worked out as a percentage in order to facilitate comparison.

CONCLUSIONS FROM THESE TABLES:

The calculated values for the occipito-frontal and biparietal dimensions from 200 - 350 millimeters crown-heel length show very small deviations from the corresponding observed averages. The most significant observation to be made from these tables is that the deviations are increased in the last part of the distribution (400 - 500 millimeters crown-heel length) where birth moulding becomes an important factor. The mean absolute deviations, as determined by various criteria applied to the several empirical formulae, range from 1.5 to 2.5 millimeters. Both dimensions are much decreased by head moulding between 35 and 55 centimeter crown-heel length

A COMPARISON OF THE (3)

TABLE 23

CROWN-HEEL LENGTH (Millimeters)		of s.	Calculated values at 5 cm C-H length		
RANGE	MEAN		CH	Value	% increment
200-250	225.3		25	62.75	23
250-300	272.I		30	74.50	I9
300-350	323.9		35	86.25	I6
350-400	370.6		40	98.00	I3
400-450	423.6		45	I09.75	I2
450-500	47I.4		50	I22.50	I0
500-550	523.4		55	I34.75	0

and the deviations of the calculated means are therefore augmented in this part of the progression.

In the selection of their cases for biometric studies, Scammon and Calkins employed a method of selection which eliminated to a large degree the error introduced by birth moulding, so that the resulting averages represent a close approximation to the full term head in utero. (They also used their figures as a standard for the correction of data obtained from stillborn material.) Their figures approach more nearly the actual measurements of the full term foetus inutero since the cases on which they are based "have not been subjected to moulding nor have they been increased by growth in the period between birth and the fourth day when many of the published figures were taken."

Their assertion that birth moulding was eliminated in their studies, is not completely correct for, as can be seen from table 23 & 24, the deviations of the observed values for the occipito-frontal and biparietal dimensions from the calculated mean based on empirical formula compiled from twenty sets of data, <u>becomes increasingly great as the size of the foetus increases.</u> It is concluded therefore, that moulding was present to a degree which, while it may have been barely palpable was

A COMPARISON OF THE COMPUTED AND ACTUAL VALUES FOR THE BIPARIETAL DIAMETER. (369 CASES)

(0.19 CH (m.m.) + 20 m.m.

TABLE 24

CROWN-HEEL LENGTH Millimeters		Crown-Rump Length	BIPARIETAL OBSERVED			Calculated Mean	Difference between (a) & (b)		No. of Cases.	Calculated values at 5 cm C-H length		
RANGE	MEAN	m.m.	Max.	Min.	Mean(a)	(b)	m.m.	%		CH	Value	% increment.
200-250	225.3	152.3	54	35	45.3	44.8	-0.5	0-1.1	52	25	49.5	24
250-300	273.1	183.9	66	43	53.9	55.9	0.0	0.0	46	30	59.0	19
300-350	323.9	223.7	77	52	62.5	63.5	+1.0	+ 1.6	36	35	68.5	16
350-400	376.6	248.2	78	58	69.6	72.4	+2.8	+ 4.0	36	46	78.0	14
400-450	423.2	287.9	84	66	77.3	82.4	+5.1	+ 6.6	29	45	87.5	12
450 -500	471.4	318.5	99	76	87.0	91.6	+4.6	+ 5.3	24	50	97.0	11
500-550	523.4	358.1	102	85	94.0	101.4	+7.4	+ 7.9	27	55	106.5	16

none the less of an order sufficiently great to be manifest as a significant deviation by this method of analysis.

Since the caesarean sections were all elective we are left with the conclusion that even easy breech deliveries may be associated with a degree of moulding which significantly influences craniometrical studies.

THE COMPUTED CEPHALIC INDEX:

Using the computed values as determined from the formulae established by graphic methods, we find the cephalic index at different crown-heel lengths to be as follows :-

TABLE 25.

CROWN-HEEL LENGTH	CEPHALIC INDEX
5 Centimeters	72.8
25 "	78.8
50 "	79.8

none the less of an order sufficiently great to be manifest as a significant deviation by this method of analysis.

Since the caesarean sections were all elective we are left with the conclusion that even easy breech deliveries may be associated with a degree of moulding which significantly influences craniometrical studies.

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Using the computed values as determined from the formulae established by graphic methods, we find the cephalic index at different crown-heel lengths to be as follows :-

TABLE 25.

CROWN-HEEL LENGTH	CEPHALIC INDEX
5 Centimeters	72.8
25 "	78.8
50 "	79.8

In terms of foetal or lunar months it may be stated that the index is 75.2 at three months, 79.2 at six months and 79.8 at term.

The accuracy of the calculated cephalic index is brought out by the following comparison with Scammon and Calkins' carefully selected biometric studies.

TABLE 26

CROWN-HEEL LENGTH	CALCULATED INDEX	OBSERVED INDEX
450 - 500 m.m	79.79	79.8
500 - 550 m.m	79.8	80.204

Table 26.

The "slight" and "very slight" moulding which was present in fifteen of the Scammon-Calkins series, does not materially affect the computation of this index for, as already pointed out, the effect of moulding was to reduce both diameters (one-twelfth for the occipito-frontal and one-eleventh for the biparietal) so that the error in determination of the cephalic index is correspondingly minimised.

These figures in table 26, will be used for comparisons with Bantu infants later in this section.

ABSTRACTS FROM THE STUDIES OF WORKERS QUOTED IN THIS INQUIRY.

1. Calkins and Scammon (1925, 1929) Empirical formulae, computed by graphic methods by the method of averages, and by the method of least squares. Thirty-three infants were studied. Measurements were made in the first day of postnatal life. Individual cases published in detail, including notation of sex.

2. Caspar (1854) Measurements of 247 full term, newborn children (living and stillborn) and of 94 foetuses.

3. Spondi (1857) Measurements of the biparietal and occipito-frontal diameters of 100, living, newborn Zurich children.

4. Depaul (1879) Records of several cranial dimensions of 100 living, newborn children. Material sexed cases from Paris?

5. Solaves (1881) Studies on 100 living newborn children ranging from 40 to 57 centimeters crown-heel length. Individual case records published including notation of sex.

6. Lafaille (1893) Measurements of a total of 152 speci-

-imens ranging from 17.5 to 56 centimeter crown-heel length. Living material with the exception of a few of the smaller individuals. Details concerning six, parity and presentation, duration of pregnancy and age of mother given.

7. Weiss (1897) Cranial (and other) measurements were made on foetuses of the fourth to tenth lunar months and of newborn children. Material from Budapest.

8. Corrado (1899) Data on the heads of a series of specimens from 10.3 to 62.6 centimeter crown-heel length. Material from Naples.

9. Heuser Measurements made of 61 specimens ranging from thirteen to forty-one weeks in estimated age.

10. Kjölseth (1913) A total of 534 living newborn infants were investigated. Unfortunately no individual case records were published.

11. Friedenthal (1914) Ten specimens ranging from 50.82 to 500.5 millimeter crown-heel length. All material caucasian with one exception (Negro.)

THE ASSESSMENT OF THE UNMOULDED HEAD OF THE NEWBORN INFANT IN THE BANTU.

1) SELECTION OF MATERIAL.

a) Racial :

An earlier section of this work is devoted to the influence of dolichocephaly on the course of labour in occipito-posterior positions. The aim of these cephalometric investigations was to determine to what extent the inherited cranial form is present before the onset of labour in the term foetus. While dolichocephaly is a pronounced characteristic of the indigenous inhabitants of Southern Africa, the assumption that the same configuration is present in their offspring before or at birth must be regarded as untenable in the absence of scientific proof. The literature is marked by a conspicuous paucity of studies of the type which could be regarded as truly comparative. Philip[65] examined hundreds of cases of breech delivery; his conclusion is best given in his own words, "……..in the newborn there is not yet any inherited cranial form, at any rate not in such a way that any influence on the course of labour could be expected." His investigation concerned only one racial group of average (mesaticephalic) cephalic index. The inherited cranial form in these cases would

have cranial characteristics as inconspicuous as their parents and therefore little could be gained from such a study. The approach to the problem of congenital cranial form in relationship to individual variations in parental cranial morphology is apt to be without profit when the cranial characteristic of the parent is an isolated or rare occurrence among the members of his racial group, that is, a personal peculiarity rather than a racial trait.

The investigation of the newborn infants skull was carried out at the New Somerset Hospital over the period 1955 - 1957 (June). The patients delivered in this institution are all Non-European. The Bantu group constitutes approximately one-third of the total number of patients.

The cephalometric and craniometric studies were confined to infants of pure Zulu-Xosa heritage - that is pure in so far as this quality was determinable by interrogation of the parents and a study of their physical characteristics. A valuable guide as to the Zulu-Xosa origin of the maternal side of the infants ancestry was the presence of tribal markings and mutilations such as amputation of the distal phalanx of the left little finger, three incised scars on each cheek, and more extensive cruciate body marks. Whenever possible the father was also questioned as to his

ancestry and any tribal markings noted.

The custom of ritual body-marking and mutilation is a dwindling one amongst these tribes. It is only practised to a large degree in the reserves. The city-born and city-bred Bantu have broken away from this practice; indeed the custom is scorned by them. The absence of any tribal marking therefore does not refute the individuals stated tribal origin. Those mothers who had no tribal markings were questioned carefully for the presence of any racial admixture and where any doubt existed either from the individual's appearance or replies to questions, the case was not selected for investigation.

A control series of craniometrical investigations was also done and for this purpose Coloured infants were selected. This may at first appear to be a peculiar selection for a control group in this type of investigation but it was one of necessity rather than volition for the Cape Coloured and the Bantu are the main two ethnic groups delivered at the Somerset Hospital. The numbers of Cape Malay, Hindu and Moslem Indians at this institution are very small. Comment has already been made on the fact that there has been no recordable contribution from the Bantu group to the Cape Coloured although the latter have as one branch of their authropological tree a Negroid group

which while they differed from the Bantu grossly, resembled them in for example the cranial form. Many caucasian sub-groups have contributed to and have been blended into the make-up of the Cape Coloured people. The cranial form which should be dominant in this people therefore, could not be anticipated.

2) THE OBSTETRICAL SELECTION OF MATERIAL.

For reasons already mentioned this investigation was to be done only on those cases where moulding could not have occured. Guidance was sought from the literature as to the selection of cases. One of the conclusions reached was that moulding could be very marked in premature breech-born infants (page 146). A more detailed and critical analysis of a large series of cases investigated by two thorough and careful workers (namely, Scammon and Calkins) revealed that the moulding present in mature breech-born infants could appreciably alter the occipito-frontal and biparietal diameter; but because the reduction in each diameter was approximately the same when expressed as a percentage of the total dimension, the cephalic index was not materially affected. (page 142.)

Cases of elective caesarean section were therefore

ideally suitable for this study. No case of caesarean section performed even a few hours after the onset of labour, as for example in cases of prolapse of the cord very early in parturition, is included in the series. It was feared that the inclusion of such cases would have cast doubt on the accuracy of the investigations. Some of these cases were 'measured' by radiological methods and in order to determine whether moulding had occured may have necessitated repeated X-rays in the early puerperium to detect any rapid restoration to unmoulded proportions. The cumulative effects of several X-rays on the newborn's skull may have been responsible for effects not predictable at the time.

Initally I used cases of easy breech delivery in multiparae as well as the breech-born second of twins. In several cases moulding was overtly present and the use of this type of case was discontinued.

The Material used in this study may be classified as follows:

I. Bantu Infants. Total 50 Cases.

a) Elective Caesarean section for disproportion - 21 cases.

b) Caesarean section after the 38th.

week of gestation for fulminating toxaemia 7 cases.

c) Caesarean section for placenta praevia (not in labour) 17 cases.

d) All other indications (vaginal abnormality, repeated stillbirths, pelvic tumour, patient with an ileal bladder, prolapse of cord in patient not in labour.) 5 cases.

2. COLOURED INFANTS. TOTAL 50 CASES.

a) Elective Caesarean section for disproportion. 23 cases.

b) Caesarean section after the 38th week of gestation for fulminating toxaemia 10 cases.

c) Caesarean section for placenta praevia not in labour. 11 cases.

d) Other indications including vaginal abnormality, uterus didelphys pelvic tumours,

Diabetes Mellitus, accidental haemorrhage. 5 cases.

METHOD OF INVESTIGATION.

Two methods of investigation were employed: 50 Bantu and 50 Coloured classified on the previous page, were all measured directly using an engineer's caliper with a vernier scale. This study goes by the descriptive term cephalometry. In addition measurements were made on the cranium by the method of triangulation radiography, employing stereoscopic methods. Anthropologists distinguish between cephalometry and measurements made on the cranium itself; they use the term craniometry in connection with the latter type of investigation. A brief description will be given of the radiological method employed.

Two exposures are made on single or separate films. The solution of the problem of X-ray distortion requires the use of a marker to denote the X and Z axes on the films as suggested by Manganiello (1948). The marker is centered and fastened on the cassette in order to prevent a shift of the marker image from the true axial line on the second exposure.

The simplest and most practical marker is a thin

rectangular piece of metal such as an ampoule file, with a notch in the centre on one side (Carabelli, 1954). Cassettes are marked with intersecting central lines which correspond to the X and Z axes on the films. The notched side of the marker is placed along one axis thereby avoiding any possible error as to which side of the marker is the axial line. The notch is made to correspond with the other axis and the marker is attached to the cassette with adhesive tape.

The first exposure is made with the roetgen tube in the central position. The central ray of the tube is directed to the centre of the marker and the film. The second exposure is made with the tube at the same height but after it has been shifted horizontally, a distance of 5 centimeters. The tube is shifted on its arm to the same side always, to establish a standard procedure which serves to identify the direction of the tube shift and so facilitate the choosing of the proper image for measurements.

The following geometric diagram illustrates what happend by using this roentgeno-graphic procedure when dealing with horizontal diameters. The two images of a horizontal diameter will be equal in length and parallel to each other. The two displacements or the separation of

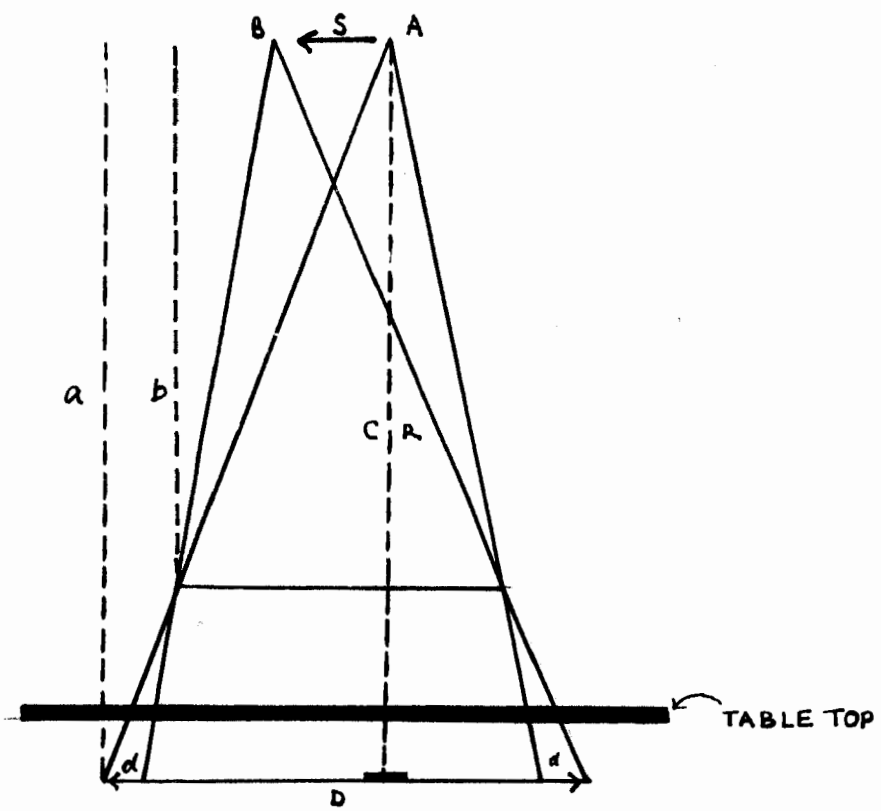
the end points of the two images ('parallax shift') will be equal. This parallax shift can be measured and using logarithm or specially prepared graphs the correction factor may be obtained.

The method which I employed is that advocated by Carabello. From the diagram the basic formula derived is the correction factor :

$$\frac{S}{S + d} = \frac{\text{Tube Shift}}{\text{Tube Shift + Displacement of Second Image}}$$

Where S = Tube Shift

d = Displacement of second image.



A = First position of roentgen tube.

B = Second position of roentgen tube.

s = Tube shift.

O = actual diameter to be compared.

D = Diameter of images.

d = displacement of images.

a = Target-film distance.

b = Target-object distance.

In this diagram we note :-

1) $$\frac{b}{a} = \frac{s}{s} + d$$

and

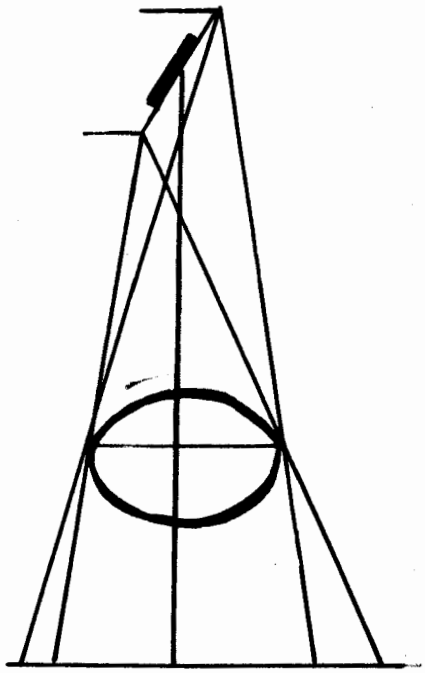
2) $$\frac{b}{a} = \frac{O}{D}$$

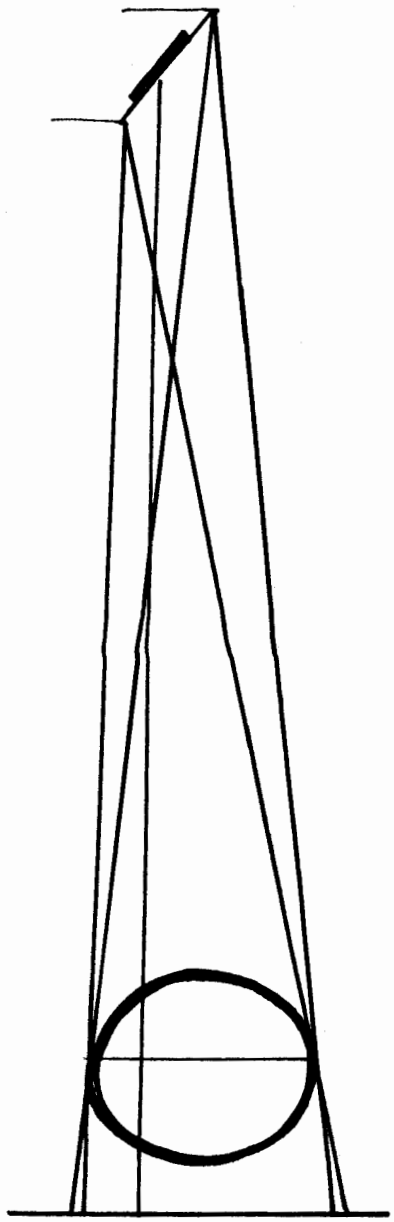
therefore:

3) $$O = \left(\frac{s}{s + d}\right) D.$$

There are certain features of practical importance which may be mentioned here. The tube-film distance controls the degree of magnification of the object as well as the sharpness of detail. The greater this distance

the smaller the magnification and the sharper the detail. These points are demonstrated in the following diagrams. I found a tube-film distance of 36 inches (91 centimeters) satisfactory for this investigation.





This study was conducted on the widest diameter of the head (in two separate views) and it was essential that the shadow cast on the X-ray negative was in fact the widest diameter concerned. By placing the tube close to the film inaccurate results will have been obtained, whereas by increasing the tube-film distance to a maximum not only was blurring practically eliminated, but also this precaution ensured that the widest diameter was cast on the X-ray negative.

The third problem of practical significance concerned the positioning of the infant's head before the exposures were made. The correction factor, as obtained by the method outlined, is only of value provided the diameter being studied is parallel to the film (or table top.) Incorrect positioning was manifest by the two images being unequal and the two displacements not equidistant. Such films could unfortunately not be used in this study. Since each of the two diameters studied required two exposures, it was considered injudicious to repeat the investigation.

For the occipito-frontal exposure the infant's head was placed in such a position that the inion and glabella were an equal distance above the table top. This was achieved by simply measuring the distance with an ordinary ruler; the position was maintained by placing a folded

linen cloth under the temporal region and the aid of an assistant. A similar procedure was followed for the biparietal exposure except that the aid of a steadying folded cloth was unnecessary. The final assessment of the accuracy of the positioning was to be found in the films: as already stated, when the diameter studied is parallel to the film the images are equal in magnitude. Any films which showed unequal images were rejected. Forty-seven craniometries were conducted in this manner.

The material may be classified as follows:

Bantu .....13 cases.

1. Multiparous Breeches : 9

2. Breech-born infants : 3
   (the second of twins)

3. Caesarean infants : 1

Coloured .....18 cases.

1. Multiparous breeches : 12

2. Breech-born infants : 4
   (the second of twins)

3. Caesarean infants : 2

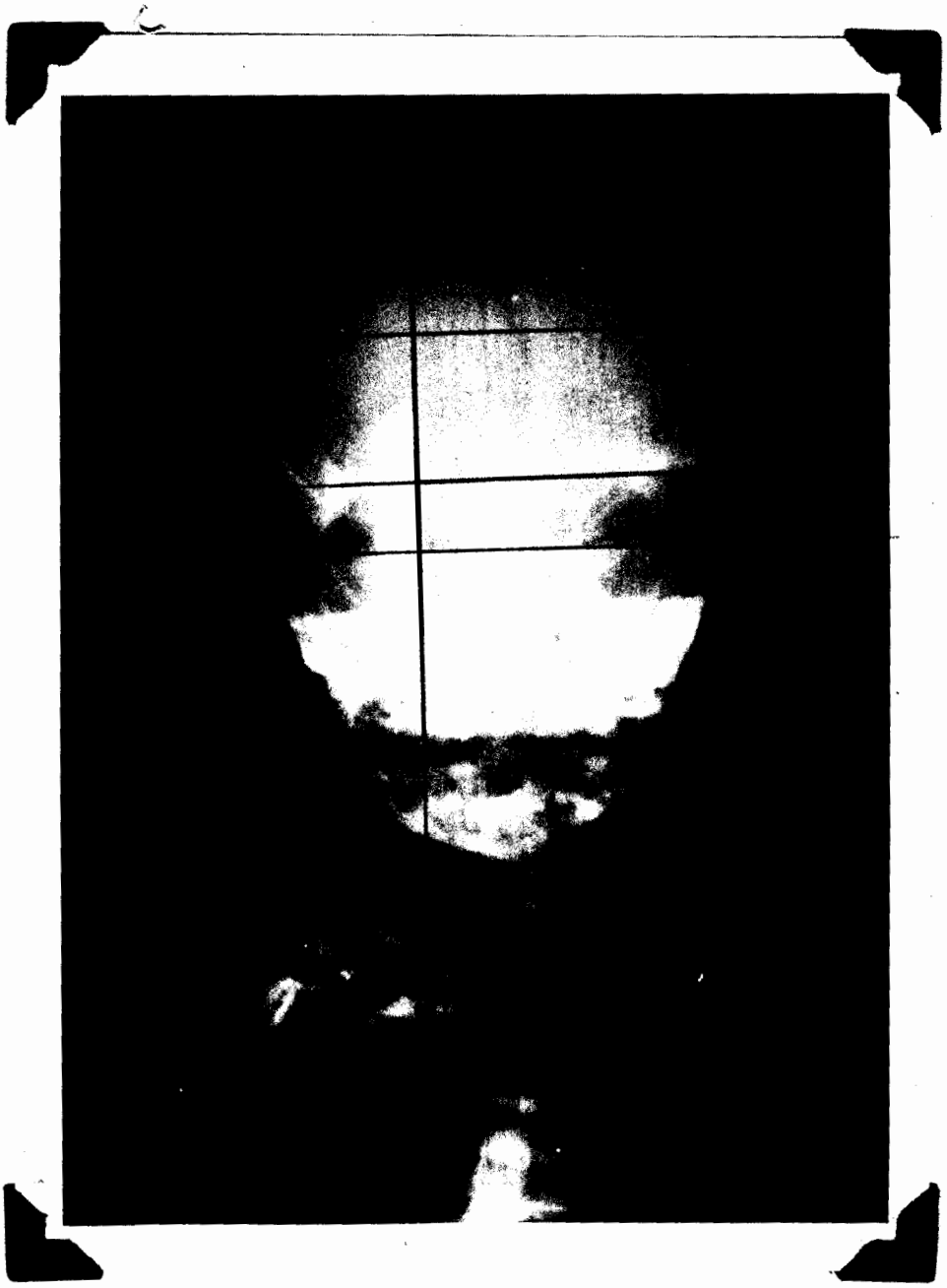


ILLUSTRATION VI

(SEE PAGE 168.)

(THE PARALLAX SHIFT IS NOT CLEARLY SHOWN IN THIS REPRODUCTION. C = CORONAL SUTURE.)

Sixteen films were found to be unsuitable. This represents a high percentage of failure (34 per cent.) Radiological craniometry, performed by the method I adapted, thus left much to be desired. The method was costly and one out of every three films proved unsatisfactory for use. There was another reason why this method was discontinued shortly after the commencement of the study, namely, the accuracy with which direct mensuration could be carried out as well as the ease with which the identification of the anterior end-point of the occipito-frontal diameter (glabella) could be made - a procedure which was often difficult on the X-ray film. All infants were measured within 24 hours after birth, with only one exception.

RESULTS, COMPARISON, CONCLUSION.

(a) Method of analysis.[66.]

The frequency distribution of each measurement was tabulated, after choosing a suitable class interval. The arithmetic mean (a) and the standard deviation (σ) were the calculated. In order to compare the data obtained in the two groups, calculations were made to de-

-termine the critical ratio between the two means of each index. This calculation involves first of all the determination of the standard error of the mean (σ_a) according to the formula

$$\sigma_a = \frac{\sigma}{n} \quad (n = \text{number of observations.})$$

The standard error of the mean for the Bantu group may be written as σ_a, for the Coloured group as σ_a^2 and that for the Seammon-Calkins series as σ_a^3. The next step was the calculation of the standard error of the differences (σ diff.) using the formula

$$\sigma \text{ diff.} = \sigma_a^1 + \sigma_a^2 \text{ ; for example,}$$

if the comparison is between Bantu and Coloured. Having obtained the standard error of the difference, the critical ratio is determined by the formula.

$$\text{Critical ratio} = \frac{\text{actual difference between means}}{\sigma \text{ diff.}}$$

According to the laws of probability the significance of the numerical values obtained for the critical ratio is as follows. If the critical ratio is 2.5, a difference between the two means equal to or greater than the observed difference is not likely to be found in more

MEASUREMENTS ON UNMOULDED HEADS OF NEWBORN INFANTS.

BANTU INFANTS.

TABLE 27.

NUMBER	SEX	AGE IN HOURS.	CROWN-HEEL LENGTH. m m.	BIPARIETAL DIAMETER m m.	OCCIPITO-FRONTAL DIAMETER m m.
1	F	2	495	90	115
2	M	7	488	89	114
3	M	4	490	89	115
4	F	8½	495	91	115
5	M	24	498	91	116
6	F	6	495	92	116
7	F	10	495	91	115
8	M	14	510	93	117
9	F	17½	500	92	116
10	F	18	495	92	116
11	M	5	505	93	118
12	M	1½	485	91	116
13	M	3	510	93	118
14	M	4	495	92	116
15	F	12½	495	92	116
16	M	22½	490	90	115
17	F	17	495	91	115

MEASUREMENTS OF UNMOULDED HEADS OF NEWBORN INFANTS.

BANTU INFANTS. (Continued)

TABLE 27.

NUMBER	SEX	AGE IN HOURS.	CROWN-HEEL LENGTH. m m.	BIPARIETAL DIAMETER m m.	OCCIPITO-FRONTAL DIAMETER m m.
18	F	4	515	93	118
19	M	9	490	90	116
20	F	2½	495	91	116
21	F	11	485	90	114
22	M	17	498	92	117
23	F	13	500	93	117
24	M	13½	495	90	113
25	F	1½	495	91	115
26	M	7	490	90	116
27	M	10	495	91	117
28	F	14	505	93	118
29	M	11½	490	90	117
30	F	4	495	92	117
31	F	22	490	90	115
32	M	14	485	89	115
33	M	18	485	88	117
34	F	16	495	92	117

MEASUREMENTS ON UNMOULDED HEADS OF NEWBORN INFANTS.

BANTU INFANTS.(Continued)

TABLE 27.

NUMBER	SEX	AGE IN HOURS.	CROWN-HEEL LENGTH. m m.	BIPARIETAL DIAMETER m m.	OCCIPITO-FRONTAL DIAMETER m m.
35	M	2	495	91	116
36	M	7	490	91	116
37	M	9	515	95	118
38	F	5	498	91	116
39	F	15	495	92	118
40	M	14	495	91	117
41	F	5	490	91	115
42	M	9	510	94	117
43	F	18	495	92	116
44	F	15	490	92	117
45	F	4	495	91	115
46	M	11	498	91	116
47	F	6	485	89	114
48	M	10	492	90	115
49	F	5	495	92	116
50	F	5	480	89	114

MEASUREMENTS ON UNMOULDED HEADS OF NEWBORN INFANTS.

CAPE COLOURED INFANTS.

TABLE 28.

NUMBER	SEX	AGE IN HOURS.	CROWN-HEEL LENGTH. m m.	BIPARIETAL DIAMETER m m.	OCCIPITO-FRONTAL DIAMETER m m.
1	F	10	495	92	114
2	M	2	500	94	116
3	M	7	515	95	117
4	F	4½	500	92	114
5	M	15	505	92	114
6	F	16	495	93	118
7	F	2	490	92	116
8	M	7	500	93	117
9	F	1½	515	94	118
10	M	5	500	93	116
11	F	9	490	92	115
12	M	6	500	93	117
13	F	15	495	92	116
14	M	17	485	91	115
15	M	2	480	92	117
16	F	22	495	92	114
17	M	1½	510	93	116

MEASUREMENTS ON UNMOULDED HEADS OF NEWBORN INFANTS.

CAPE COLOURED INFANTS. (Continued)

TABLE 28.

NUMBER	SEX	AGE IN HOURS.	CROWN-HEEL LENGTH m m.	BIPARIETAL DIAMETER m m.	OCCIPITO-FRONTAL DIAMETER m m.
18	F	17	495	92	114
19	F	5	490	90	112
20	M	4	495	92	114
21	F	9	485	91	112
22	M	21	500	92	113
23	F	4	480	89	113
24	F	7½	510	93	116
25	M	11	485	90	111
26	M	22½	490	91	113
27	F	1	485	89	112
28	M	7	495	92	115
29	F	9	495	92	115
30	F	8	490	91	114
31	M	3½	500	92	112
32	M	6	515	93	115
33	F	15	495	90	112
34	M	7	505	93	113

MEASUREMENTS ON UNMOULDED HEADS OF NEWBORN INFANTS.

CAPE COLOURED INFANTS. (Continued)

TABLE 28.

NUMBER	SEX	AGE IN HOURS.	CROWN-HEEL LENGTH. m m.	BIPARIETAL DIAMETER m m.	OCCIPITO-FRONTAL DIAMETER m m.
35	M	4	495	92	113
36	F	1	490	89	114
37	M	7	495	91	116
38	M	8	490	92	117
39	F	15	495	91	116
40	F	9	495	92	117
41	M	22½	515	94	118
42	F	11	500	92	117
43	F	23	510	93	116
44	F	17	500	94	118
45	M	17	495	92	116
46	F	9	495	92	112
47	F	7	505	93	114
48	M	4	485	91	112
49	M	9	500	92	113
50	M	2	495	92	114

RADIOLOGICAL CRANIOMETRY.

BANTU INFANTS.

TABLE 29.

Number.	Sex	Age in Hours.	Crown-heel length M.M.	Biparietal M.M.	Occipito-Frontal M.M.
I	F	2	495	9I2	II6
2	M	I	505	9I3	II6
3	F	I½	500	9I0	II5
4	M	3	495	9I3	II6
5	F	4	485	9I2	II3
6	M	I7½	490	9I0	II4
7	F	8	5I0	9I4	II7
8	M	22	5I5	9I4	II7
9	F	2I	500	9I2	II5
I0	F	4	495	9I3	II6
II	F	I½	490	9I2	II4
I2	M	7	495	9I2	II4
I3	M	9	485	9II	II3
		M E A N S		9I.28	II5

RADIOLOGICAL CRANIOMETRY.

Coloured Infants.

TABLE 30.

Number.	Sex.	Age in Hours.	Crown-heel Length.	Biparietal Diameter. m.m.	Occipito-frontal Diameter. m.m.
I	M	2	505	93	II5
2	F	I	5I0	93	II4
3	F	7	500	92	II4
4	M	8	495	9I	II3
5	F	2	490	94	II6
6	M	4	485	9I	II4
7	M	I	495	92	II4
8	M	7	495	9I	II3
9	F	9	500	92	II4
I0	M	4	485	9I	II3
II	F	9	505	90	II4
I2	M	22	495	94	II6
I3	F	2I	490	9I	II4
I4	M	I8	49I	90	II2
I5	M	3	5I5	94	III
I6	F	4	500	90	II4
I7	F	2	5I0	93	II0
I8	F	I	500	93	II2
			M E A N	9I.9	II3.3

MEAN VALUES FOR THE TWO DIMENSIONS STUDIED.

(Millimetres)

TABLE 31.

DIMENSION	BANTU	CAPE COLOURED.
BIPARIETAL	91.54	92.22
OCCIPITO-FRONTAL	116.0	114.7

THE CEPHALIC INDEX.

TABLE 32.

	BANTU	CAPE COLOURED.
CEPHALIC INDEX (a)	78.52	80.38
STANDARD DEVIATION (σ)	0.2573	0.4377
STANDARD ERROR OF THE MEAN (σ_a)	0.03639	0.0691
STANDARD ERROR OF THE DIFFERENCE σ diff	0.07178	
CRITICAL RADIO	25.90	

than 6 out of I,000 comparisons of groups drawn from similar population groups. Hence we are justified in concluding that the observed difference is almost certainly due to systematic and not to chance factors; in other words, that the observed difference is significant. Such a conclusion is all the more justified if the critical ratio exceeds 2.5, the significance becoming more and more important as the critical ratio increases.

COMPARISON.

The results of the cephalometrical studies are recorded in the following tables. The average biparietal diameter for the Bantu series was found to be 91.54 millimeters, which is appreciably lower than that of obstetric teaching. Scammon and Calkins[67] cite 35 series from authors who publish means for this dimension. The range for the biparietal diameter based on the findings of all these workers is 85.4 (Fasbender) to I00.0 millimeters (Liharžik and Webster). The mean obtained by Meigs (Philadelphia, 1843) is not included in these calculations, for this author obtained a value of 137.6 millimeters for the biparietal diameter and 122.8 for the occipito-frontal measurement. The mean for the biparietal diameter based on the work of 35 authors is 93.61

millimeters. In only 8 series are the means smaller than that for Bantu newborn infants; in the remaining 27 series the value is greater. It may therefore be stated, that the biparietal diameter in the full term Bantu foetus is in the lower limits of the range for this measurement is obtained by different authors. It is of interest to note that such workers as de Lee (92.5), Williams (92.5), Jönner (92.5) and Hecker (92.2) obtained values lower than the average (93.61 millimeters) for all workers.

The mean for the Coloured infants in my series was 92.22 millimeters which agrees fairly closely with the means of the authors quoted in the previous paragraph. It is only 0.68 millimeters less than the corresponding figure for Bantu infants. No significance can be attached to the difference.

The occipito-frontal diameter for Bantu infants is 116.0 millimeters whereas that for the Coloured group is only 114.7 millimeters. The range, according to calculations based on 28 series of measurements is 110.0 to 120.0 millimeters. (Again, Meigs' figure of 122.8 for this dimension is not included.) The mean is found to be 115.7 millimeters. It may be said of the Bantu value

of 116.0 millimeters, that it is barely above, the average and is in the higher reaches of the range of this dimension. Different workers have obtained widely varying results in their assessment of the occipito-frontal dimension. Thus de Lee and Williams, who obtained identical means for the biparietal diameter, found the occipito-frontal measurement to be 110.0 and 117.5 millimeters in their respective series. The figure of 114.7 for Coloured infants is slightly below the average.

In the 29 series listed by Scammon and Calkins, 12 authors obtained a smaller and 17 a greater value (for the occipito-frontal diameter,) than in the Bantu.

The cephalic index for Bantu and Coloured infants was calculated on the basis of the values obtained by direct measurement. The Bantu index of 78.52 is significantly lower than the Coloured group index of 80.38. The difference (1.86) is found to be 25.09 times (critical ratio) the standard error of the difference.

CONCLUSION.

An attempt has been made to determine the dimensions of the head in the term foetus in two groups of people. It is clear that English obstetric teaching

places the value for the biparietal dimension higher than the determinations of recent workers. This difference is probably because obstetric teaching is based on measurements made four and even five days after birth. While this delay in assessing the biparietal diameter has the advantage of being done on a head which has largely recovered from the moulding effects of parturition, it unfortunately introduces an error due to growth. The same may be said of the occipito-frontal dimension.

The Bantu and Coloured infants investigated had to be compared with more or less acceptable means for the two dimensions studied. These means were calculated from all available sources in the past twelve decades. Different authors exercised varying degrees of caution in their selection of material. The detailed specification of the material is not stated in all cases. Nonetheless, for want of a better standard or acceptable norm the arithmetic mean of numerous authors was used as a basis for comparison.

From the results of my investigations it is evident that the head of the full term Bantu foetus does not differ very markedly from that of the Caucasian. The shorter biparietal and longer occipito-frontal dimensions in the South African Negro suggest that the head is

slightly narrower and longer than in, for example, the Coloured group which differs not at all from the Caucasian.

The assessment of cranial form will be considered in greater detail under the heading 'Cephalic Index.'

While the results of a small series of craniometric (as opposed to cephalometric) investigations are tabulated, these figures were not used in the determination of the cephalic index.

THE CEPHALIC INDEX:

Computations, based on the results obtained from the cephalometric studies conducted at the New Somerset Hospital, yield a cephalic index for Cape Coloured infants which is almost identical to that obtained by Scammon and Calkins in their biometric investigations. Thus the index of 80.38 for my series of fifty cases does not differ appreciably from their figure of

The mean index for a series of 50 Bantu infants was 78.52 and this differs significantly from that for Coloured infants. These two indices were subjected to

statistical analysis according to the formulae referred to on page 176 and a critical ratio of 25.90 was obtained. Hence one is justified in concluding that the observed difference (1.86) between the arithmetic means for the two series of cases, is almost certainly due to systematic and not to chance factors; in other words, these cephalometric studies show that Bantu infants, are more dolichocephalic than Cape Coloured infants at birth.

This difference between the two groups of infants, may at first sight appear contrary to one's expectations when one recalls that the Cape Coloured People include among their ancestors certain Southern Negroid ethnic groups namely, the Bushman (cephalic index 75.8) and Hottentots (cephalic index 70.5). Moreover Bush-Hottentots hybrids have been shown to have an index of 73.4 which is roughly an average of the two individual groups. Reasoning in a purely arithmetical way one would expect the index for the Cape Coloured people to be lower than its proven figure of 75.8 (Martin)[68]. However, the inheritance of cranial characters seems to be a complex affair (Fawcett and Pearson, 1898)[69], probably because so many independent variables are involved in the process, that it cannot be expressed in simple Mendelian factors.

The fact that isolated inbreeding can produce a fairly stable and constant mean cephalic index, and the further fact that interbreeding between diverse stable groups introduces modifications in the descendants, indicate that hereditary transmission is a factor of some importance. The complexity of the problem of inheritance emerges from the measurements made by Sullivan[70] (1919) on the 'Samar' united twins of whom Lucio had a cephalic index of 80.8, Simplicio an index of 85.5.

However, while the genetics of head form are not simply resolvable, it must be conceded that within a homogeneous group under stable conditions, the cephalic index remains constant for a long time, and this must be due mainly to hereditary transmission.

Environment is another factor of importance which must be borne in mind. Boas was probably the first to adduce substantial evidence in support of the view that a change in environment may influence the head form of the new generation. To summarise briefly: the observations indicate that those with a high mean native cephalic index tend to show a fall in the first American-born generation. The outcome of the mass of confusing, and sometimes conflicting, evidence which has been pub-

lished on the subject seems to be that a change in environment - a change usually for the better - may be sufficient to jolt the hereditary mechanism out of its accustomed groove. The alteration effected is not uniform: high indices are down graded, low indices are up graded, those in between are unchanged. There is an increasing body of evidence to suggest that a favourable environment induces a trend towards a common headform with an index at the lower limit of brachycephaly (Abbie).

There is thus no method by which the inherited cranial form of these people with their multiracial origin can be predicted. The adult index if 75.8 and in the term foetus the index is no different from that for example obtained by Scammon and Calkins on their investigations. The computed index based on empiric formula also shows no appreciable difference from that for Cape Coloured and American infants. In an earlier section an index of 79.8 was regarded as the norm for newborn infants in whom no moulding had occurred. Yet different observers have obtained widely differing results in their studies on the full term foetus. As already indicated, insufficient care in the selection ofmaterial was the main factor responsible for this lack of uniformity in results. A second consideration concerns the question

of race; to what extent do racial factors influence the cephalic index in the term foetus? In table 22 are recorded the indices which I have calculated from the investigations of different workers. The work of the three French workers (Ribemont, Depaul and Solares) show close agreement, the index being just above 80. Indices below 75 were obtained by two workers namely, Spondi (German) and Kjölseth working in Christiana. Their series are however, too small (six and one) to form the basis of discussion and comparison even if the values quoted are correct. However, Caspar (Rhenish) in a series of 79 cases obtained an index of 76.57.

Ever since its inception the cephalic index has remained the major criterion of human affinities and development. On the other hand, states Abbie, anyone who has measured a series of skulls must have realised that the loci from which the index is calculated vary from skull to skull, and that the index expresses something different for every skull. Nevertheless, Morant[72] (1918) claims that only one character has been found which is capable of making an absolute distinction between more than one of the groups (i.e. of humans) and that is the cephalic index. Thus the value of the index is established, but it can be accepted only as a total response to a

number of variable factors, some of which are probably obscure (Abbie)[7].

Abbie[7], who adopts the attitude of his 1947 paper, of seeking some unifying principle under the apparent diversity of a multitude of observations, considers headform in relation to many factors including race and individual development. He finds "the term 'race' objectionable, both on politico-sociological grounds and because it is used equally for the whole human species and for sections of that species." The fact that the child's head is generally rounder than the adults is recognised in the term 'infantile' commonly applied to those with a high cephalic index. However, while the rounder head is more like the infant's in many groups it is not so in all, nor is the process of head development from infancy to adulthood always comparable from one group to another. He also points out that the "curve of skull maturation is different "....?where the adult index is high" and is emphatic that the cephalic index at birth is 'much the same for both dolichocephalic and brachycephalic' Ranke (1905) Martin (1928), Klein (1935) and Kappers (1945) also state that the cephalic index in the newborn is in the lower 80's being less than the adult mean. It seems clear states Abbie, that no matter what may be the mean cephalic

index of parents, the mean index of the newborn falls within a very restricted range which is close to the lower limit of brachycephaly. He checked his view by measuring the heads of thirty-nine European infants - sixteen males and twenty-three females, aged from 1 to 22 days and without head moulding. The mean cephalic index for the males was 78.39 (range 74.3 - 82.6, the mean for the females was 78.4 range 73.6 - 84.2). The combined mean was 78.4. Five full term, undeformed European foetuses gave a mean of 82.0. He does not state the mode of delivery or parity of the mothers nor does he define the term European which may include peoples of widely varying cephalic index such as the Germans (73.7) and the Swiss and Tirolese (84.4 and 85.0 respectively).

In addition, Ranke (1905) has published figures for 20 European infants (age 1 to 21 days) : eleven males gave an index of 81.5, nine females a mean of 80.7 so that the combined mean for his series was 81.5. The mean for the newborn European foetus as based on the figures of Ranke and Abbie is 80.5 (64 observations).

It appears that the shape of the head in the term foetus tends to mesocephaly. The widely differing results obtained by different workers are explainable in

two ways: accurate results will only be obtained if :-

a) The infants selected for study are delivered by caesarean section in the last two weeks of gestation without the prior occurrence of labour pains; the moulding which takes place in utero in the last two weeks of pregnancy (Philip)is inconstant and negligible although it may on occasion produce a spalding sign.

b) The measurements are made within twenty-four hours after birth. A much longer delay will yield inaccurate results because of growth and, as pointed out by Davenport (1926), the tremendous alteration in the head immediately after birth in attaining specific headform.

There seems to be more or less general agreement that moulding temporarily impresses dolichocephalic effects on the skull. But this is not necessarily always

so for, as previously stated, the degree of flexion and the position of the head are important in deciding the nature and degree of moulding. The converse is also true namely, that moulding can impress brachycephalic effects on the skull. Abbie, for example, in his paper on "Headform and Human Evolution," refers to an aboriginal skull of a newly born infant which "unfortunately, retains a good deal of birth moulding. As it is, the skull has a cranial index of 86, but even the most generous allowance for distortion leaves the index still over 80." In this case moulding had converted a paedocephalic skull into a markedly brachycephalic one.

In conclusion it may be said of headform that there is a foetal norm, restricted to a small range of indices from 78 to 82 (Abbie). Skull differentiation shows four stages of which the first is a common human stage at birth. Common human heredity determines headform until birth. The investigations of workers in the past hundred years have been analysed both in regard to the material used and the methods employed. Particular attention has been paid to the work of Scammon and Calkins and from theoretical calculations based on formulae as well as actual observations, the average cephalic index in the term foetus is computed to be 79.8.

Bantu and Cape Coloured infants were studied, special care being taken to avoid the unpredictable alteration of cranial form introduced by head moulding. The findings from my investigations show that the term Bantu foetus has an index which falls within the lowest limits of what anatomists and anthropologists have come to accept as normal for the human race. By comparison the Cape Coloured foetus has an index which is identical to what may be regarded as the average for the human term foetus. Statistical analysis of the difference shows that it is greater than can be accounted for by chance factors. One of the features brought out by this cephalometric study is the greater frequency of true dolichocephalic forms among Bantu term foetuses. The term dolichocephaly as used here is according to the index grouping suggested by Abbie: brachycephaly - over 82; dolichocephaly - under 78. No difference in cephalic index was demonstrated between males and females of either group investigated.

PART TWO.

THE MANAGEMENT OF PERSISTENT OCCIPITO-POSTERIOR POSITIONS.

THE MANAGEMENT OF PERSISTENT OCCIPITO-POSTERIOR POSITIONS

"Intelligent expectancy is the treatment until an indication for intervention arises" (de Lee)[73]. Armed with the knowledge that many such patients fail to have any greater difficulty than a prolonged second stage, watchful expectancy must be practised until one of the following reasons for aiding the natural forces arises:-

a) Maternal distress.

b) Foetal distress, as indicated by definite changes in heart rate and other well-known signs.

c) Cessation of the progress of labour.

This discussion concerns particularly the need for intervention when progress in labour has ceased. The statement that the time to interfere, is when the natural forces have been given adequate opportunity to achieve natural delivery, carries several important implications. Obviously if progress does not cease and if anterior rotation occurs with subsequent normal birth, this is an ideal state of affairs and well rewards the patience

expended. In other cases labour may continue to progress and the head may be finally born with the occiput posterior. This also represents a satisfactory outcome of the case and is much to be preferred to any form of operative interference. There remains the third group of cases in which progress is arrested, the point being reached, beyond which, further descent, flexion, and rotation of the head is not possible without assistance and in some instances, impossible even with manual and forceps intervention.

There is no certain method of predicting in which particular category of these three, a parturient will be ultimately classified. Only a trial of labour will tell and it is for this reason that the conservative note in treatment has been widely sounded. The natural forces should be given every opportunity of effecting a natural rotation and delivery. But in leaving to nature the task of achieving this desirable result, it is of value to weigh the chances and to attempt to predict the probable outcome of a particular labour. There are however, two unpredictable determining factors, namely, the degree of moulding which can occur before foetal well-being is jeopardised and the continued efficacy of uterine contraction. Nonetheless, in assessing the probability of the outcome of labour, there are certain observations which aid the obstetrician

in reaching a decision.

Foetal size is a factor of paramount importance in any labour. The accurate assessment of size or weight in the term foetus is a matter of some difficulty. The variation in weight at term is, almost one hundred per cent. Yet by feeling the body of the foetus and palpating the head, most obstetricians will be able to state whether the foetus is big or small, whether it weighs well over eight pounds or definitely under this figure. It is known, from experience, that the rate of operative delivery in occipito-posterior positions rises markedly when the baby weighs over eight pounds - more markedly so than with occipito-anterior positions. An analysis of the birth-weights in my series of persistent occipito-posterior positions, shows that the largestinfants were those which were stillborn and delivered vaginally with forceps assistance, as well as those infants which died in the first twenty-four hours after forceps delivery (Page 5a).

The shape of the pelvis has an important role in determining the outcome of labour in occipito-posterior positions. The android pelvis is associated with an appreciably higher operative delivery rate in occipito-posterior than in occipito-anterior positions (Page 62). The caesarean section rate particularly, in the former type of

case, reaches the high figure of 17 per cent. Clinical assessment of a pelvis yields much valuable information and should always be done. Radiological pelvimetry is a valuable aid to clinical assessment particularly because it gives details of the shape of the pelvis - which is not always determinable digitally even by the experienced obstetrician. Similarly, radiology may show up a 'high assimilation' anthropoid pelvis where clinical assessment may have failed to detect it. The role of the different pelvic forms on the course of labour in occipito-posterior positions has been already discussed in Part 1.

It may be stated that those cases of occipito-posterior position associated with a normal pelvis, will rotate spontaneously and deliver as anterior positions, but only after optimal descent and moulding have taken place. Rotation, as a rule, is a long process and takes place late in the second stage which is often prolonged. The realisation that a persistent occipito-posterior position is often a necessary adaptation of the foetal head to the type of pelvis in which it occurs, should stay the obstetrician's hand, unless a definite indication to assist the course of labour, is present. The natural forces should be given the opportunity to achieve

natural rotation. One cannot always do with the hand (or forceps) what nature accomplishes only after hours of tedious rotation, if at all.

THE TIME OF INTERVENTION.

It is generally agreed that with good uterine action and no overt disproportion, the majority of cases will rotate spontaneously and deliver unassisted. In the rest intervention, in an obstetrical sense, is necessary. In the absence of maternal and foetal distress, how long should labour be allowed to continue? Many arbitrary standards have been proposed. When an indication is accepted as a fixed standard it loses its value and is liable to be responsible for the practice of incorrect midwifery by the inexperienced.

Here are some of the standards which have been proposed, tried and rejected in the past few decades: till the cervix is fully dilated, till the patient has had six hours of good pains, two hours after the membranes rupture, when the second stage has been in progress for two hours in multiparous parturients and three hours in primiparae. When these arbitrary standards are subjected to conscientious and constructive criticism, obvious

objections are raised to all of them. Obstetrically one cannot think in terms of fixed times and, to use an expression which through repetition has become hackneyed, each case should be judged and treated on its merits.

To wait for full dilatation may, on the surface, seem a sound policy, but will, in some cases, prove a dangerous standard to adopt. In cases of brim contraction or undiagnosed hydrocephalus, the cervix may never dilate fully, and to wait for full dilatation may mean a dangerous delay during which there is an increasing risk of infection of the amniotic fluid, of foetal death, of rupture of the uterus and, perhaps, the development of constriction ring in multiparae.

The effective expulsive power of the uterus varies so enormously from case to case that to wait for intervention until the patient has had six hours of 'good pains' is to utilise a time system where so many variable factors exist, that the system is useless. Any given fixed time period, even if the contractions are good, may be an insufficient test for one parturient and to long a test for another.

To allow labour to continue until the membranes rupture may, on the surface, seem a reasonable policy. But the foetal membranes vary so much in toughness that

their rupture cannot be accepted as a token that the uterus has exerted its maximal force. Also, the membranes are known to rupture prematurely more commonly in occipito-posterior than, for example, in anterior positions.

It is the obstetrician himself who must decide - by his clinical assessment of the maternal mental and physical condition, the foetal heart rate, the force of the uterine contractions, the ability of the uterus to relax between pains, by his accurate knowledge of the size and shape of the pelvis, the size of the foetus, a knowledge of the parturient's previous labours, and above all, the evidence of descent of the head as furnished by both abdominal and vaginal examination. A lateral skiagram may be invaluable in the difficult case. At the Somerset Hospital we have a high emergency rate - up to 30 per cent of our admissions are non-booked cases. In addition, a large number of patients attend only once or twice in the whole antenatal period, so that we not infrequently have in labour a case which had last been seen some two or three months previously. Antepartum pelvic assessment will not have been done in this type of case. While we regard these as non-booked admissions we do not record them in our annual reports as such.

When the type of patient just described runs into obstetric difficulties with the occiput posterior, an X-ray in labour is of great value. The following information may be obtained from the films.

a) The relation of the head to the pelvic landmarks: In an obese or well-built patient it may be difficult to state whether the head is engaged on clinical examination.

b) Angulation of the foetal neck; this is likely to occur where there is a high angle of pelvic inclination. It is an unfavourable sign because it indicates some misdirection of uterine thrust, the components of whose force tend to be directed in front of the symphysis pubis instead of into the cavity of the pelvis.

c) In parturients who have not had an X-ray pelvimetry, additional

information will be furnished concerning the presence of a false promontory, the shape and fullness of the sacral bay, the width of the sacro-sciatic notch, and lastly, the measurement of the obstetric conjugate - if it differs from the true conjugate.

d) The relative lengths of the occipital and frontal levers.

It requires much judgment, acquired through experience, to decide when the point has been reached, beyond which a further wait is inadvisable. The rising height of the bladder into the abdomen, often with a blood-tinged urine, the increasing difficulty in micturition and even catheterisation, as well as the late results of overstretched uterine ligamentary supports, are constantly borne in mind. The usual signs of maternal and foetal distress are taken into consideration. It is to be remembered that serious intracranial damage may develop before any signs are discernible. It is to be suspected when uterine contractions are strong and frequent and rotation is not resulting. Increasing

extension of the head in a pelvis inadequate to accommodate the occipito-frontal diameter or even a lesser dimension, at the level of impaction, is the usual combination of circumstances which defy the best efforts of the uterus to achieve descent, rotation, and delivery. The labour is in every way an obstructed one. The reaction of the patient's uterus to the insuperable obstruction presented by these circumstances is dependent on the parity of the parturient. In the primigravida failing uterine action in the face of difficulty is the most usual outcome. In the multigravida uterine activity builds up into a crescendo, which may terminate in rupture of the organ.

Intervention too late is fraught with many many difficulties to the obstetrician and dangers to mother and foetus. Strong contractions may have, by then, produced so much moulding that anterior rotation, manually or with the forceps, becomes difficult or even impossible.

The realisation that some prolongation of labour is to be expected with these positions may increase our equanimity in managing them. Those lacking this realisation may be led astray by their fears, and failing to see what nature can accomplish, indulge in meddlesome midwifery. One principle of first stage

management - and it applies to any presentation - is the relief of pain in labour. "It is indicated by every consideration of humanity and good practice. It conserves the strength and the well-being of the mother as nothing does, and if used judiciously, does not injure the baby." (A.H. Bill.) A certain amount of dilatation is not deemed necessary as an index for the time to commence analgesia. The mere fact that a patient has pains which hurt, is in itself sufficient indication regardless of the degree of dilatation.

METHODS OF INTERVENTION.

A. Manual Rotation and Forceps Extraction.

There are numerous methods of terminating labour and achieving delivery per vias naturales. In the conservative school of thought, this nearly always takes the form of manual rotation and forceps extraction - a prodecure which has proven its worth to all those who have conscientiously attempted it. In the series of persistent occipito-posterior positions investigated, the percentage of success in attempted manual rotation, was only 50.25 per cent, that is, there was a failure to effect rotation manually, once in every two cases. In

those cases in which attempts at manual rotation were unsuccessful, the head was delivered face-to-pubes, without harmful result to mother or child. This naturally raises the question whether it is necessary routinely to attempt rotation before applying the forceps. It may be argued thus :-

a) If pelvic configuration and the attitude of the poorly flexed head, as well as the numerous factors which influence the length of the occipital lever, are the main determining factors in the causation of persistent occipito-posterior positions - and such they are - nature has already indicated the optimal position of the head by arresting the occiput posteriorly.

b) That if the natural uterine forces, after an effort of hours in some cases, have been unable to rotate the vertex anteriorly against the bony resis-

-tance of the pelvic side walls, the accoucheur's hand would not be able to achieve this in a few minutes, if at all.

c) That damage of an intracranial nature was being courted by doing what nature had failed to achieve.

d) Lastly - that those posteriors which can be rotated manually, would have rotated in any case, had there been allowed a longer trial period.

These are points of view which have been expressed by obstetricians in personal communications. These arguments, which are not lacking in substance, are not completely correct. The pelvis may only be narrowed at one level in the transverse diameter due to say, very prominent inward-pointing spines, associated with a degree of convergence of the side walls of the pelvis. A cross-section of the pelvis at this station, will show it to be oval in shape, with the long axis of

the head in the antero-posterior diameter of the pelvis. The head may be poorly flexed so that the diameter presented to and held up by the narrowest available dimension of the pelvis, is oval in section. Rotation then, whether by uterine activity or manually, is not possible.

If labour must be terminated because of, say, a failure of progress, then it becomes important to recognise the relationship between the long oval of the head and the long oval of the plane of arrest and to realise that rotation cannot be accomplished at the level of impaction. It is impossible to rotate one bony oval within another. Rotation necessitates an upward displacement of the head and an attempt to procure flexion is a sine qua non, before the manoeuvre is carried out. The achievement of flexion is a decided advantage, since it aids the mechanism of rotation and descent of the head for it changes the girdle of cranial contact from the occipito-frontal to the suboccipito-bregmatic plane, so that the cross-section of the foetal head at or above the plane of impaction, is changed from a long oval to a circle. A smaller diameter is therefore presented to the narrowest part of the pelvis. Rotation and forceps extraction now become possible.

The question naturally arises whether there

are indications for forceps delivery in the face-to-pubes position. It appears that the dangers to the maternal soft tissues have been exaggerated in the past. In my own series of 388 persistent occipito-posterior positions, there was only one third degree tear - and that in a case in which anterior rotation was easily performed. Nonetheless, the more extensive second degree tears are seen in association with forceps face-to-pubes deliveries. The reason for this has already been discussed. Many obstetricians point out that the dangers are more apparent than real, more theoretical than actual. The literature of the past two decades shows conflicting views as to the advisability and indications of delivering certain posteriors in the unrotated position.

The earlier writers, on this aspect of the occipito-posterior position, do not recognise any indications for delivery as such, resorting to it only when all attempts at rotation had proved unsuccessful. Thus Gilbert Strachan[74] (Textbook of Obstetrics, 1947) states that "In the very rare cases in which rotation has failed and the head is low in the pelvis, with the foetus alive, forceps extraction of the head 'face-to-pubes' may be performed, and extensive perineal lacer-

ation may be prevented by performing lateral episiotomy. Again if the head is impacted and the foetus is known to be dead, craniotomy should be performed, and this may even be indicated when the foetus is alive but impacted." He adds that caesarean section should be reserved for cases that fail to enter the brim usually as a result of deflexion or weak pains or both.

Professor Eastman[88] (writing ten years later) states that the decision to deliver the head as a posterior "depends fundamentally on whether or not factors are present which threaten to make artificial rotation especially difficult". He states also that if the operator's experience with manual or forceps rotation is meagre, delivery of the posterior occiput as such, is usually the safest procedure. In other words, in his opinion, the "best type of operative procedure to be employed will depend on the experience and training of the operator, the type of pelvis, the degree of moulding of the foetal head and the size of the infant." This statement contains conflicting implications (William's Obstetrics, IIth Edition, page 838.) He continues, however, in a more lucid manner in stating that "if the head is considerably moulded (as will often occur if patience has been exercised in allowing time for spontaneous rotation), delivery by

forceps as an occiput posterior will usually prove the least.traumatic measure both to mother and child." He adds that the same is true, in his opinion, if the pelvis is anthropoid or android in type or shows mid-pelvic contraction.

Titus[75.] (1945) finds rotation "actually inadvisable" ..... "if the head is low in the pelvis or on the perineum." This is his only indication for delivery face-to-pubis. (Management of Obstetric Difficulties, 3rd Edition, page 552).

There are three types of case in which delivery as a posterior is desirable and advisable.

a) In the case of persistent occipito-posterior position, occurring in a parturient who has a proven anthropoid pelvis, having a high posterior sagittal index, a deep sacral bay and a narrow transverse diameters at all levels, compensated for by the antero-posterior dimensions, it is best to achieve delivery as a posterior.

Here I may reiterate (see page 96) the mode of delivery in lower mammals. As term approaches the foetus is rotated round to a dorsi-sacral positions, the head engaging as a primary occipito-sacral position. The head then (in labour) traverses the whole length of the pelvis and is born with the occiput behind and in an attitude of extension. With the exception of certain primates, all these animals have pelvic indices well above 100. The following list has been compiled by Topinard (ref: Revue d'Anthropologie, 1874-5).

Macropodidae		139
Rodentia		133
Carnivora		132
Ungulata artiodactyla		123
Primates:	Lemuroidea	144
	Cebidae	135
	Cercopithecidae	134
	Simidae (Hylobates)	121
	Chimpanzee	97
	Simia	83
	Gorilla	79

In studying the scale of pelvic indices, we see that it is in the chimpanzee that the index first

falls below 100. It is in this particular primate that there first is noted a lack of the constancy with which the occiput is posterior at delivery unlike other mammals of higher pelvic index. The observed modes of delivery in chimpanzees in captivity, is quoted elsewhere in this inquiry (page 96 .)

b) The second indication for delivery as an occipito-posterior is the uncommon primary occipito-sacral (dorsi-sacral-) position. These cases are often diagnosable during pregnancy. Radiographically, the foetal spine is seen in apposition to the maternal spine, and the 'true posterior' position of the head may be noted. These cases as a rule do not rotate. Ninety per cent of these cases are associated with anthropoid pelves according to D'Esopo. This has been my own experience also; out of nine cases seen at our antenatal clinics, seven had true anthropoid pelves, in one instance

the pelvis was anthropoid-android and the remaining case had an android pelvis.

c) Should one rotate the occiput which has come the whole length of the pelvic strait in a posterior position, only to be arrested in the final stages by the resistance of the maternal soft tissues or failing uterine action as well as lack of maternal voluntary expulsive effort. Some obstetricians argue that the occiput should be rotated as whatever level its progress is arrested. Reasoning in the light of the figure for spontaneous delivery as occipito-posteriors, namely, fifteen per cent, one may contend that, had not the uterine and maternal forces been inadequate, the head which traversed the whole length of the maternal pelvis would have delivered as

a spontaneous face-to-pubis.
It is not necessary to rotate
the head in this type of case.

In the management of persistent occipito-posterior positions a knowledge of the maternal pelvic form and capacity is essential before any manoeuvre is carried out. The problem is largely one of deciding the optimal position of the occiput. Present day opinion is not unanimous as to the exact attitude to be adopted; while some recognise indications for delivery of the occipito-posterior as such, others feel that the practice of anterior rotation should be routine. There is however, no fixed dictum which should guide the obstetrician; the only sign posts are pelvic morphology, the level at which progress in labour has ceased and the presence or absence of extension.

There are certain cases which should be rotated posteriorly rather than anteriorly; they form a small but definite group. Take the hypothetical case (referred to in (c) above) of the parturient who would have delivered spontaneously as a face-to-pubis had not uterine action failed. This is one type of case in which rotation is unnecessary. As already indica-

-ted, the pelvic form in such cases is usually of the anthropoid type except where the foetus is very small, when no particular type of pelvis may be found.

Forty cases of spontaneous delivery, as occipito-posterior positions, were analysed.

A control group was constituted by forty parturients in whom the position of the passenger at the onset of labour was occipito-posterior, but in whom spontaneous anterior rotation occurred. In both series, only those cases in which the infants weighed over seven pounds were selected. The sacral index was calculated from the X-ray pelvimetry films in each case. The sacral index may be defined as the ratio of the perpendicular from the chord of the sacrum to the deepest part of the sacral curvature expressed as a percentage of the total chord length. The average chord length "is 25.1 centimeters in whites and 13.2 centimeters in the black race." (Paterson, quoted by Duckworth)[76]. No attempt was made in my investigations to compare the two ethnic groups studied. The results of the investigations are tabulated below.

In this table it is shown that the sacral index is appreciably higher in those cases which delivered

spontaneously as posteriors than in the group in which spontaneous rotation occurred.

	S. F. T. P.	S.A.R.
SACRAL INDEX.	24	16

S.F.T.P. = Spontaneous face-to-pubis delivery:

S. A. R. = Spontaneous anterior rotation.

The only clear indication for posterior rotation is a pelvis having a deep posterior segment, a well curved sacrum (i.e. of high sacral index) and a fore-pelvis which is overtly narrow. Delivery as a posterior, in such cases, is rational and practicable.

Eastman ('Williams Obstetrics' IIth Edition, page 838) states that "if the head is considerably moulded, (as will occur if patience has been exercised in allowing time for spontaneous rotation), delivery by forceps as an occipito-posterior will usually prove the least traumatic to mother and child." Considerable moulding, with the head well-flexed, usually indicates a degree of cephalo-pelvic disproportion. The same is not necessarily true if the head is partially extended.

The indication to deliver the well moulded head as a posterior is a questionable one. Certainly, if the head is low, that is, with the biparietal diameter well below the ischial spines, forceps should be applied. With the head low and partially extended an attempt to procure flexion should be made. In the more difficult case, with the head arrested at a higher station, a caesarean section offers the best prognosis for the foetus. Reference has been made already to the high foetal mortality in persistent occipito-posterior positions, when the baby weighs over eight pounds.

Formerly, only the high-forceps operation was condemned. But "during the last 10 to 20 years it has been convincingly demonstrated that many mid-forceps operations, even though technically possible, are prejudicial to the health and life of both mother and child." (Jeffcoate,[77] "The Present Position of the Forceps Operation") He continues thus: "Difficult mid-forceps operations have therefore become fewer and fewer, the safer alternative of caesarean section being preferred." The trend in the past ten years and more, has been to deliver by caesarean section babies which previously would have been born dead with forceps, while those stillborn as a result of spontaneous delivery are

now extracted alive with forceps.

It is reiterated, that when there has been marked moulding and the station of the biparietal diameter is not well below the ischial spine, caesarean section should be considered rather than entertaining the prospect of a difficult mid-forceps. When the estimated weight of the baby is over eight pounds and moulding is marked, a caesarean section should be even more seriously considered.

FORCEPS ROTATION.

"I luckily thought of trying to raise the head with the forceps, and in turn the forehead to the left side of the brim of the pelvis, where it was widest, an expedient which I immediately executed with greater ease than expected. I then brought down the vertex to the right ischium, turned it below the pubes, and the forehead into the hollow of the sacrum, and safely delivered the head by pulling it up from the perineum and over the pubes. This method succeeding so well gave me great joy, and was the first hint, in consequence of which I deviated from

the common method of pulling forcibly along, and fixing the forceps at random on the head."

Thus wrote William Smellie[78] ("the greatest of all obstetricians" - Cameron) two centuries ago. Forceps rotation of the lagging occiput has long been accepted as a recognised procedure in these cases. Many obstetricians were not overwhelmed with enthusiasm for it in the beginning and were rather reluctant to recognise its value. Strachan[79] (1947) writing on this aspect of posterior positions states that "Rotation by forceps was advocated by William Smellie, but has now quite properly fallen into disrepute. With the head low in the pelvis short straight forceps might rotate the head without great harm, although some twisting of the neck with imperfect rotation of the shoulders is likely....." For these reasons, and as manual methods of rotation are so much more satisfactory, forceps rotation of a posterior occiput should not be employed. (Strachan)

Kielland of Christiana, in 1916 described a forceps with narrow somewhat bayonet-shaped blades. He claimed that this instrument surpassed all other models as a rotator. Originally designed for cases

of transverse arrest of the head, these forceps have also been advocated as of particular value in delivery of persistent occipito-posterior positions. The instrument has now been in existence for forty years, yet many practising obstetricians have not become familiar with their use. Perhaps the success which usually attends attempts at manual rotation has made the need for a greater familiarity with Kiellands' instrument a very small one.[90] Over the period 1948 - 1954 Kiellands' forceps was used on three occasions at two maternity hospitals in Cape Town; the percentage of successful manual and forceps rotations was only 56 per cent in the series of cases studied at these two hospitals.

In latter years there as been a sharp drop in manual rotation in favour of total forceps rotation and a progressive increase in the use of this instrument in preference to other types (Cosgrove.)[80.] Many feel that it represents the best expedient for artificial rotation. Kiellands' instrument makes possible a true cephalic application, regardless of the station of the head which is impossible with the usual long curved forceps. It achieves its objective by interrupting the pelvic curve at the commencement of the shanks which are bent forward at a slight angle with

the blades. The sliding lock caters for varying degrees of asynclitism. Risks to the baby are considerably reduced because far less compression to the foetal skull can be achieved across the fulcrum of the sliding lock. Also the ability to obtain an accurate cephalic application enormously lessens the strain upon the tentorium cerebelli.

Those who have mastered the technique of using Kielland's forceps are enthusiastic, and most of the criticism comes from ignorant or prejudiced sources." (Donald)

The instrument is not without its disadvantages. Perhaps the one most commonly encountered is the risk of damage to the vagina and perineum. This is partly due to the sliding and therefore unstable lock. Donald (Practical Obstetric Problems) reports also spiral tears of the vagina and tears of the cervix and mentions the possibility of bladder injury.

Barton's forceps, of more recent origin, is well spoken of by Caldwell, Studdiford and Bachman. It differs from the usual types in that the anterior blade is hinged where it joins the shank. It's use is even less common than that of Kielland's instrument, in this

country.

SCANZONI'S MANOEUVRE AND ITS MODIFICATIONS.

The double application of forceps which was first described by Smellie and rediscovered by Scanzoni nearly a century later, has given satisfactory results in some hands but it is rarely necessary, and is generally employed in only a small percentage of persistent posterior positions. The need for a double application is occasioned by the fact that the first application is made with the pelvic curve correctly orientated. After rotation the blades become inverted so that the pelvic curve looks posteriorly and an attempted delivery with the instrument in this position is likely to cause serious injury to the maternal soft parts.

Scanzoni's manoeuvre has never been widely practised in Great Britain. Ian Donald,[81] for example, states that this procedure is "so crude by comparison with a rotation with Kielland's forceps that it does not really merit description." He adds that "there are few operations in all midwifery so satisfying as a correctly performed delivery with a Kiellands forceps." (Practical Obstetrical Problems.)

In the United States of America, the manoeuvre has been more widely practised and has undergone several modifications, the most notable among which are those associated with the names of Bill and King. Paul Titus[82] ("The Management Of Obstetric Difficulties") states that is "conservative and logical always to attempt manual rotation forward before resorting to the Scanzoni manoeuvre." If this practice is adopted, he adds, the Scanzoni manoeuvre will be found unnecessary in many instances. If however, manual rotation cannot be accomplished readily, he finds the logical choice a Scanzoni double application with rotation after the technique best described by Bill. He looks upon it as a comparatively simple and highly effective procedure when properly done and not the difficult and traumatising operation which many believe it to be. "Williams taught its principles and Efficacy, and in consequence the majority of his former assistants strongly favour its use."

D'Esopo[83] has described a procedure of forceps rotation which may be effective when other manoeuvres fail. It is primarily indicated in those cases associated with prominent spines and flat posterior segment. Here rotation cannot be accomplished at the level of arrest. It is best in these cases to lift the head slightly above the

level of impaction against the spines, apply the forceps and rotate to the transverse position. Then by lateral flexion the head is brought into the retropubic space, away from the spines where low rotation can be accomplished. The technique, however, requires good transverse width in front of the spines to allow the head to be brought into the retropubic space as a transverse.

RADICAL METHODS IN THE MANAGEMENT OF PERSISTENT OCCIPITO-POSTERIOR POSITIONS.

The American author, Arthur H. Bill, is probably the best known exponent of the radical trend of thought. He states that it is equally faulty to interfere too early, that is in the first stage, or to wait too long after full dilatation. It is in the definition of too early and too late that the differences between radicalism and conservatism are discerned. That Bill is relatively radical is revealed in his caution in stating that he offers his scheme of management for "trained obstetricians only and not as a compromise of ideals to suit the methods which are within the resources of physicians, unfamiliar with obstetric procedures or without the judgment essential to proper application of

methods."

Bill is the epitome of radicalism. His figures bring out more eloquently than words, the radicalism which is the hall-mark of his attitude to persistent occipito-posterior positions.

a) He does internal podalic version if the head remains unengaged at the beginning of the second stage. This happens in 63.4 per cent of his occipito-posterior positions - a figure which will be nearer 80 per cent if he were to practice among the Bantu.

b) He allows only one hour in the second stage for spontaneous rotation to occur and accepts a forceps incidence of 34.4 per cent.

Bill's indication for intervention in the second stage is not acceptable to us. Another pointer to his extreme radicalism is his manoeuvre for forceps

rotation (Bill's manoeuvre). It is really a modification of the Scanzoni double application of forceps. Only 2.2 per cent of occipito-posteriors escape being pulled out feet first or head first. His radicalism makes nearly every occipito-posterior a persistent occipito-posterior position.

Before those who subscribe to a more conservative school of thought, criticise Bill, they should view his methods against the background of his results. They should recall that the foetal mortality in his recorded series was only one per cent. Also it must be remembered that in each individual's hands, the method which by training and experience is easiest for him and yields best results, is best for him.

However, Bill places himself at variance with most writers in the following ways :

a) He does not allow a long enough trial period in the second stage before terminating labour.

Probably most of his cases if given an adequate trial would deliver vaginally. Spontaneous vaginal delivery is, as a rule, preferable to any other mode of delivery. If the pelvis is adequate the foetus not

very large and the history of previous labours satisfactory, the labour should be allowed to continue, unless progress is not noted. From past experience it is known, that the vast majority of such parturients achieve a normal unassisted delivery after a second stage which is a little prolonged. It is felt therefore, that in many instances Bill is achieving by force in a short time, what nature would have achieved gradually.

b) He is constrained to do internal version on grounds which are not acceptable.

The place of internal version has become an increasingly small one amongst obstetric procedures in the last few years. The main reason for this is the high foetal mortality associated with a manoeuvre which in addition, is not without danger to the parturient. An analysis of the statistics for posterior positions, leads one to the inevitable conclusion that in a high percentage of cases he does internal versions when vaginal delivery, without or with forceps assistance, would have taken place.

c) He uses a time factor as his only indication for intervention.

This criterion for intervention does not take

into consideration the need for a longer than average second stage in order to achieve long internal rotation. Ordinarily, rotation takes place late in the second stage, when the occiput has reached the level of the pelvic floor. In many parturients who have been in the second stage for one hour, the head has not reached a level at which rotation has occurred or is expected to take place. Yet a high proportion of these women deliver vaginally without forceps assistance. To intervene after one hour, is to deny many women the priviledge of natural delivery.

DIGITAL ROTATION OF THE FOETAL HEAD BEFORE FULL DILATATION.

Intervention may, on occasion, be necessary for arrested progress during the first stage of labour. There is a very small literature on this aspect of the management of posterior positions. Weet as long ago as 1856, (quoted by Playfair)[84], advocated flexion of the head by pressure on the frontal bones to bring the head "within the actions which favour rotation." Playfair himself advocated "pressure on the pubic side of the head during pains." William Hunter[85] (1953) states that "In general, when intervention is necessary in the first stage, it is

sufficient to rotate the occiput to the front and to allow labour to proceed normally until the cervix is fully dilated. This rotation should not be unduly delayed if the progress is unsatisfactory, as early intervention in such cases shortens labour and reduces the period of suffering of the mother to a minimum...."
The additional advantages of a successfully attempted rotation are staged by Hunter to be a decreased likelihood of draining away of liquor aminii and the formation of contraction ring , and an adequate reserve of strength of the patient as well as a diminished risk of foetal distress and infection, because labour will have been advanced by a major step.

The indications for intervention in the first stage, listed by Hunter are as follows :-

a) As soon as labour has ceased over a twelve-hour period during established labour, even when the cervix is not more than one-third dilated;

c) Occasionally foetal distress as shown by the passage of large quantities of meconium "with reasonably steady heart

sounds;"

c) In a few cases of maternal distress not responding to sedatives and not necessarily associated with prolongation of labour.

While advocating rotation of the head before full dilatation, Hunter condemns immediate delivery, since this implies the need for accouchement forcée or hysterostomatomy. To achieve rotation in some cases requires introducing the hand into the uterus to rotate the shoulder - a procedure which Hunter has had occasion to perform and one to which C.J.K. Hamilton objects contending that it causes dilatation of the cervix and could possibly be responsible for the formation of a constriction ring.

Three other objections have been raised to Hunter's practice of rotation in the first stage.

1) Professor C. Scott Russels'[86] objection is that, while there is an undoubted place for the correction of the malposition in early labour, the difficulty

is that the suitable cases are only apparent in the second stage.

2) Bender[87] states that many obstetricians have tried rotation in the first stage but were put off because this practise could lead to the patient having two anaesthetics in a short time, if rotation were unsuccessful or if forceps had subsequently to be applied for any reason, such as foetal distress.

3) A further argument advanced by Bender[87] was that rotation in the first stage might be contraindicated by the shape of the pelvis at levels below the then station of the head.

Hunter's reply to these criticisms is that he had seen contraction rings in only a few emergency cases, that rarely had two anaesthetics been required and that

his figures showed a high percentage of success. He asked his critics to try his methods.

My own experience with this practice, while being a limited one, indicates that it is of great value in properly selected cases. The type of case on which it was done was, as a rule, the multiparous parturient whose membranes had ruptured. Shortly after the onset of labour and in whom cervical dilatation was proceeding at a slow rate, the cervix being poorly applied to the presenting part. After rotation was achieved, the vertex came down to a lower level, the cervix was better applied and dilated more rapidly so that, whereas the course of labour previously was slow and difficult, it now proceeded satisfactorily.

Many of the earlier cases selected were emergency admissions sent to hospital as obstructed labours, with the story that they had been bearing down for more than two hours, without any advance. On examination the cervix was found to be not fully dilated. This desire to bear down before full dilatation, is a common phenomenon in occipito-posterior positions and is presumably due to pressure on the rectum by the prominent occiput, initiating the afferent arc of a reflex.

While it is a clinical impression that the manoeuvre is one of great benefit no control series of cases was conducted to accurately evaluate the success of the method. A similarly beneficial result seemed to accrue in cases of mento-posterior position in which dilatation and descent of the face proceeded slowly and laboriously. In all twenty-five cases of occipito-posterior position were rotated in this way. A normal delivery ensued in twenty-two cases, and three required forceps assistance. The manoeuvre was also performed in five cases of face presentation in all except one of which, natural delivery followed.

Bender's view that rotation in the first stage may be contra-indicated by the pelvic form at lower levels, is a sound one. There are certain pelves in which delivery as an occipito-posterior is the optimal mechanism. This aspect of pelvic morphology relative to occipito-posterior positions, has already been discussed . It may be reiterated that the pelvic type concerned is that in which the antero-posterior dimensions exceed the transverse measurements, the greatest transverse diameters are located nearer the sacrum than the pubes and the sacral curvature is well developed. If labour is proceeding slowly, as judged by the descent

of the already engaged head, and the pelvis possesses the physical features just described, then manual rotation will be contra-indicated. The natural outcome of labour, if the uterine action is efficient, is a spontaneous face-to-pubes delivery.

Radiological pelvimetry is a valuable aid to clinical assessment of the pelvis; the 'inlet' and 'lateral' views yielding the useful information. The emergency rate at the Somerset hospital is high; also patients who live at some distance from the hospital not infrequently default - sometimes for as long as the last three or four months of gestation and when next seen, are in labour. These parturients, like the emergency cases, will not have had a pelvic assessment. With the head engaged an accurate clinical assessment of the pelvis is difficult. When the occiput is posterior in location and labour is not progressing satisfactorily, the radiographic inlet and lateral views give much useful information which complement the clinical information, so that the decision to rotate the head in the first stage may be made with less likelihood of achieving a position which is contra-indicated by the pelvic shape at a lower level.

In the management of these cases, I have

adopted the following criteria for intervention in the first stage.

1) The patient should be multiparous. Since the manoeuvre was performed without an anaesthetic the multiparous parturient was more suitable than the primipara. An attempt to rotate the head in a primipara is best conducted under a general anaesthetic. Depending on the exact station of the head, the degree of dilatation and the way in which the cervix is applied to the presenting part, morphine or pethidine, the latter sometimes together with largactil, is administered a suitable time before the procedure is attempted.

2) The head should be engaged. If the head is not engaged it is at too high a level to be accessible to the fingers per

vaginam. Ordinarily the head rotates low down in the pelvis so that there can be no point in attempting rotation when the greatest diameter has not yet passed the inlet or even when it has just traversed the brim.

3) The cervix should be at least 'half' dilated. It is exceptional to achieve rotation through a cervix which is less dilated, without an anaesthetic.

4) The pelvis should be gynaecoid in type. The natural outcome of labour (in occipito-posterior positions) in parturients with gynaecoid pelves, is spontaneous rotation and delivery. An attempt to rotate should not be made when the pelvis is anthropoid or android in form.

5) The head should be well-flexed if rotation is to be attempted. The partially extended head has an oval outline at its greatest cross-section. Unless the pelvis is very large the attempt at rotation is doomed to failure; it is impossible to rotate one bony oval within another. The type of pelvis in which the head becomes extended is usually transversely contracted. An attempt to procure flexion by applying pressure to the sincipital extremity during contractions may be made. I have not found it of any real value in these cases.

The manoeuvre is not a difficult one. In all, rotation was attempted in thirty-two cases and succeeded in twenty-five.of the seven failures six were primiparae. As with rotation of the occiput at any other time, for example, in the second stage,

simultaneous rotation of the shoulders is carried out.

INTERNAL VERSION.

The role of internal podalic version in the management of persistent occipito-posterior positions, is a very small one indeed. Arthur H. Bill performs version in 63.4 per cent of his occipito-posterior cases and it is a little difficult to understand his rationale for doing this; when the results of management along conservative lines are good. The one redeeming feature of his tendency to turn the foetus and pull it out feet first, is the fact that he performs the manoeuvre early in labour - before uterine retraction and draining away of the liquor have become marked. This may be one reason for his low foetal mortality.

As a rule the prognosis for the child is uncertain, and depends on the indication and the difficulty experienced in extraction. Injuries to the foetal head and compression of the cord, in cases of cephalo-pelvic disproportion prolonging the delivery of the head, are the two common causes of pronounced asphyxia and death either at the time of delivery or during the

neonatal period.

Internal version is probably the oldest form of version; it was described and practised by Hippocrates and is referred to in the writings of obstetricians down through the centuries. The high foetal mortality and maternal risks associated with it, have led to its occupying an increasingly small place in modern obstetric practise. The more advanced the labour the greater does the risk to the parturient become. Even the gentlest handling provides no guarantee against uterine rupture.

In regard to occipito-posterior positions, may have to be performed under the following circumstances:

a) When the second of twins presents as an occipito-posterior and the head remains at a station too high for forceps application.

b) When prolapse of the cord is discovered at full dilatation the head being too high for forceps delivery and facilities for caesarean section are not

available.

c) Persistent compound presentation defying attempts at replacement of a hand in multiparous parturients if facilities for caesarean section are not available and the head remains too high for forceps delivery after replacing the hand.

d) When there has been an intrauterine death labour having come to a halt at or after full dilatation, the head being inaccessible to the obstetric forceps.

Each individual will adopt the course which by training and experience is best for him. It is not within the bounds of reason to lay down wider indications than those listed above. Nonetheless, the point will sometimes be reached when a decision must be made between internal version and caesarean section in multiparous parturients with good obstetric histories. In

deciding attention must be directed to the following three conditions necessary for the safe performance of the version:-

1) The membranes must be recently ruptured; there must be enough liquor to premit mobility of the foetus.

2) The uterus should relax between contractions. The foetal parts must be identifiable during uterine diastole. Tonic contraction, the moulding of the uterus over the foetus and the presence of retraction or construction ring are absolute contra-indications . The decision can sometimes only be reached when the patient is deeply anaesthetised and uterine relaxation is then noted.

3) The pelvis must be adequate. When there is disproportion from pelvic contraction or exception-

-al size of the child, breech extraction is likely to be dangerous and caesarean section should be chosen instead of version. The mortality among breech-born infants weighing over eight pounds may reach tragic proportions.

CAESAREAN SECTION.

'In these days of small families the baby's right to survival is increasingly recognised, and consequently many of the indications for the operation are now solely concerned with the interests of the infant.' There is however, no excuse for resorting to caesarean section because one lacks the obstetrical skill of a previous generation. (Ian Donald - "Practical Obstetrical Problems") Marshall states that the history of caesarean section is that of an operation constantly modified and steadily improved and until recent days in unremitting and sometimes bitter conflict with the older art of operative vaginal delivery. He adds however,

that the art of surgery has not displaced the older art - "it has only softened it, for it is of a gentler kind."

The inevitable result of the greater present day safety of abdominal delivery, due largely to antibiotics, improved anaesthesia and availability of blood transfusion, has been to lower the threshold for caesarean section in persistent occipito-posterior positions.

There are certain indisputable indications for caesarean section, namely, foetal or maternal distress in the first stage of labour. We are here concerned with the need for intervention in the second stage of labour - that is when it becomes evident that, despite adequate uterine action, progress is not resulting. The exact mode of intervention will necessarily depend on the station of the head and the shape of the pelvis. The well-flexed head, with its biparietal diameter at or below the level of the ischial spines, can nearly always be delivered by forceps. The most unfavourable cranio-pelvic relationship is that of partially extended head in an android pelvis - especially when the membranes have been ruptured for some time. Rotation of an extended head in the occipito-posterior position, is seldom possible unless an attempt is made to procure flexion and the latter

is a difficult manoeuvre. Many of these cases can be delivered by the use of considerable force. But it should always be the aim to reduce the frequency of difficult vaginal delivery and consequently the still birth and neonatal death rates from foetal asplyxia and intracranial trauma. In D'Esopo's material the incidence of cranial birth injuries has been reduced to nearly one per thousand births.

It is likely, he thinks that this attitude will prevail even more strongly and that vaginal procedures that require operative force will be performed on the rarest occasions. One of the difficulties is that no one has yet had the courage to state the figure for foetal loss in relative disproportion and dystocia which an obstetrician or an institution can justifiably accept as reasonable and permissible (Marshall). The figure to be striven for is zero. But if it is ever to be reached difficulties must be foreseen before labour begins or, at least, after its reasonable duration and not experienced at a stage of increased risk to both mother and child, whether the delivery be abdominal or vaginal. In an attempt to lower the rate of difficult vaginal delivery, caesarean section will sometimes be done unnecessarily and that shorn of all trimmings, states the problem

(Marshall).

From an analysis of the statistics for persistent occipito-posterior positions, it is concluded that the highest foetal mortality is reached when the big baby (that is, weighing over 8 pounds) is delivered vaginally. The most unfavourable combination of circumstances is the triad of big baby, primiparity and android pelvic morphology. Only the judgment based on experience will aid the accoucheur in deciding which cases are to be delivered vaginally and which are best terminated by caesarean section.

To deliver a live baby by caesarean section is a greater accomplishment than doing a difficult forceps and having a neonatal death from intracranial trauma.

The ideal is to achieve natural delivery with minimum risk to parturient and infant. Achieving this desirable objective entails a close watch on the maternal and foetal conditions. While one may logically regard the persistent occipito-posterior position as a physiological mechanism in some cases or as an adaptation between the foetal head and the maternal pelvis necessitated by a similarity in shape and capacity, the condition is hardly normal or physiological in other cases. Nor is

it without deleterious effects on both parturient and passenger.

The deleterious foetal effects are reflected in the foetal mortality. Many factors contribute to the mortality rate which is higher than with anterior positions. In this series the rate was 15.2 per cent. The prolongation of the second stage and the need for marked moulding are not without detrimental effects on the foetus. The lability of the foetal heart, both in regard to its rate and force, may be of an alarming degree towards the end of the second stage. The early rupture of the membranes probably enhances the possibility of intra-uterine infection. Many of our emergency admissions ('delay in the second stage') have temperatures when first seen. Foetal well-being is threatened by two other factors: strong contraction and prolonged uterine retraction, and moulding. The inevitable result of excessive uterine contraction and retraction is to deminish the uterine circulation so that the foetus suffers in consequence. Moulding can be very marked in persistant occipito-posterior positions. Among the Bantu we see the worst cases of moulding - the outcome of labour is to a very large extent dependent on this phenomenon. In these cases the falx cerebri becomes

drawn up, thereby kinking the great vein of Galen. Cerebral oedema is a natural sequel and with it anoxia, increased capillary permeability and focal haemorrhages. In more marked cases, the tentorium tears. Tentorial tears and other haemorrhages are the most common post-mortem findings. It is no wonder that the stillbirth and neonatal death rates are higher than with occipito-anterior positions. In this series the neonatal death rate was 5.6 per cent. It is among the Bantu that we in South Africa, most commonly see the sequence big baby, prolonged labour, occipito-posterior, mid-forceps, still birth. These cases are usually emergency admissions sent into hospital because labour is not progressing satisfactorily. When they are admitted the damage to the tentorium has already been done. The forceps are applied and a large still born baby is delivered, showing excessive moulding of the skull; or the infant, if born alive, dies after a few hours.

If the attitude of watchful expectation is to be carried out satisfactorily, the obstetrician should have a complete knowledge of the parturient's pelvis and he should judge the descent of the head by repeated abdominal palpation and vaginal examination. Hunter urges "More precise diagnosis" and "more detailed examination"

for, as he points out (quoting Hector Mac Lennan) cases are "missed because they are masked." Donald points out that occipito-posterior positions and cases of transverse arrest are responsible for as much concern as all the remaining problems commonly encountered in practice. Yet with careful observation and careful manag ment a persistent occipito-posterior position need not be dangerous either to mother or child.

I. Caldwell, W.E, Moloy, H.C. D'Escpo D.A — Amer. Journ. Obstetrics and Gynaec. (I934) 28 824.

2. Baird, D. — Combined textbook of Obstetrics and Gynaecology. 5th Edition. p 60I. (Livingstone Publication)

3. Donald, I. — Practical Obstetric Problems. Ist Edition.

4. Gibberd, O.F. — 'A short textbook of Midwifery' 4th Edition. p I28. (Churchill Press.)

5. Stern, D.M. and Burnette, C.W.F. — 'A modern practice of Obstetrics' p I42 (Bailliere Tindal and Cox Ltd.)

6. Mac Lennan, H.R. Wrigley, A.J. Percival, R. — British Obstetri. Practice p 594. (W. Heineman Publication).

7. Fink, A. — Zbl. Gynak (I952) 74/46 (I828-I83I) Excerpta Medica Vol 6, No. IO, p 480.

8. Cosgrove. — Am. J. Obst. Gynec. (I93I)Vol 3I, p 402-408

9. Bill, A.H. — Amer. Journ. Obstet. and Gynec. (I93I) 22 p 6I5.

IO. Heyns, O.S. — Journ. Obstet. and Gynaec. Brit. Emp. (I946) 53 p 405.

II. Heyns, O.S. and Shippel, S. — Journ. Obstet. and Gynaec. Brit. Emp. (I946) 53 p5I9. Vol. 53.

I2. Mac Lennan, H.R. Wrigley, A.J. Percival, R. — British Obstetric. Practice. p 583. W. Heineman Publication.

I3. Steel, K.B. and Javert, C.T. — Surg. Gynec. and Obst.(I942) 75 p 477

I4. Donald, I. — 'Practical Obstetric Problems' First Edition.

I5. Rudolph, L. and Ivy, A.C. — Amer. J. Obstet. Gynec. (I93I) 2I p 65

I6. Paramore. — Quoted by W. Hunter I953. Reference I8)

I7. Caldwell, W.E. Moloy, H.C. D'Esopo, D.A. — Amer. J. Obst. Gynec. (I934) 38 p 824

I8. Hunter, W. — J. Obstet. and Gynaec. Brit. Emp. (I953) 60 p 327

I9. Rydberg, E. — J. Obstet. Gynaec. (I935) 42 p 600 Brit. Emp.

20. Moir, J. Chassar. — Brit. Med. Journ. (I938 2 p 557

2I. Calkins, L.A. — Amer. J. Obstet. Gynae. (I947) 53 p 488

22. Grays Anatomy. 29th Edition. p 593. Longmans Green and Co.

23. Calkins, L.A. — Obstet. Gynae. (Phila.)(I953) II4 p 466

24. Jeffcoate, T.N.A. — "British Obstetric Practice" (I955) p I08 William Heineman Publication.

25. Holland, E. and Eden. — 'Manual of Obstetrics' 9th Edition p 465 (Ed.A.Brews.)Churchill Press.

26. Piper, Edmnnd, B. 'Obstetrics and Gynaecology' (I933) 2 p 88. Ed. A.H. Curtiss (W. Saunders Company)

27. Heyns, O. J. Obstet. Gynaec. (I946) 53 p 405 Brit. Emp.

28. Ince, J.H. Young, M. J. Obst. Gynaec. Brit. Emp. (I940) 47 p I30

29. Heyns, O. J. Obstet. and Gynaec. (I946) 53 p 405

30. Philipp, E. Trans. Internat. and 4th Amer. Cong. Obstet. and Gynaec. (I95I) p 236

3I. Fink, A. Zbl. Gynak (I95I) 7322 (I720-I727) Excerpta Medica Vol.5, No.7. p 347

3Ia Fink, A. Zbl. Gynak (I952) 74/46 I828 Excerpta Medica Vol.6, No. IO. p 480

32. Keane, A.H. Man Past and Present. New Edition (I920) p 84. Cambridge Univ. Press.

33. Keen, J.A. Yearbook of Physical Anthropology (I947) Viking Fund. Inc.

34. Cameron, S.J. 'A Glasgow Manual of Obstetrics' p 375 3rd Edition (Edward Arnold & Co.)

35. Vartan, C.K. "Modern Trends in Obstetrics and Gynaecolggy" Ist Edition p I99. (Ed. K. Bowes)

36. de Lee, J.B. Principles and Practice of Obstetrics. Greenhill, J.P. 9th Edition. p 538.

37. Vartan, C.K. "Modern Trends in Obstetrics & Gynaecology" Ist. Edition p I99

38. Caldwell, W.E., Moloy, H.C. — Amer. Journ. Gynec. (I933) 27 479.

39. Thoms, H., Nicholson, C. — Amer. Journ. Obst. Gynaec. (I94I) 42 957

40. Caldwell, W.E., Moloy, H.C. — Amer. Journ. Obst. Gynec. (I934) 28 482.

4I. Berman, R. — Obstetrical Roentgenology (I955) p 307. (F.A. Davis & Co.)

42. Ibid — Ibid p 9

43. McLaren, J.W. Hartley. J. Blair. — "Modern Trends in Obstetrics & Gynaecology 2nd Edition p 304, Ed. K. Bowes (Butterworth & Co)

44. Von Baer. — Quoted by Duckworth (I904) "Morphology Anthropology" p 234. Cambridge Univ. Press.

45. Moir, J. Chassar. — J. Obst. Gynaec. Brit. Emp. (I947) 53 457.

46. Duckworth, W.L.H. — Physical Anthropology. p 228 Cambridge Univ. Press.

47. Duckworth, W.L.H. — Physical Anthropology.

48. Morris Steggerda. — Am. J. Phys. Anthropology (I940) 26 4I7.

49. Barreto, A. Dionisio., S.A.J. of Science (I955) 52 No.I pI9

50. Hocart, A.M. — "The Progress of Man" Methuen & Co Ltd. London.

5I. Keane, A.H., — "Man Past & Present" (I920) p 84. Cambridge University Press.

52. Keane, A.H., "Man Past & Present" (I920) p 84. Cambridge University Press.

53. Ibid

54. Keen, J.A. "A Statistical Study of the difference between Bushman Hottentot & Bantu Skulls" p 34. Year book of Anthropology I947 (Viking Fund)

55. Davenport, C.B. Journ. Phys. Anthropol. (I940) 26 I87

56. Seammon Calkins. 'Growth in the foetal Period' (I929) p 25 University of Minnesota.

57. Ibid p 24.

58. Ibid

59. Duckworth, W.L.H. "Morphology and Anthropology" (I904) p 300 Cambridge series.

60. Stampf Quoted by Seammon & Calkins "Growth in the foetal Period" p 26

6I. Heyns, O. J. Obstet. & Gynaec. Brit. Emp. (I946) 53 405

62. Seammon Calkins. "Growth in the foetal Period" p 259

63. Ibid p 259

64. Ibid p 284

65. Philipp, E. Transactions 4th American Congress of Obstetrics & Gynae. p 24I

66. Smith, C.A.B. "Biomathematics" 3rd Edition pages 540 et seg, 569 et seg, 616 et seg. Charles Griffin & Co.

67. Scammon Calkins. "Growth in the foetal Period" (1929) p 116

68. Martin Quoted by Abbie see reference 71

69. Fawcett Pearson. Quoted by Abbie see reference 71

70. Sullivan Quoted by Abbie see reference 71

71. Abbie, A.A. "Head form and Human Evolution" Journ. Anat. (1947) part 3. vol 81. also Yearbook of Physical Anthropology (1947) p 75. (The Viking Fund Inc.)

72. Morant Quoted by Abbie Journ. Anat. (1947) vol. 81. part 3

73. de Lee, J.B. Greenhill, J.P. "Principles & Practice of Obstetrics" 9th Edition. p 541. (Saunders Co.)

74. Strachan Gilbert 'Textbook of Obstetrics' (1946) p497 (H.K. Lewis)

75. Titus, Paul. Management of Obstetric Difficulties. p 552 3rd Edition.

76 Duckworth, W.L.H. "Morphology & Anthropology" (1904) p 289. Cambridge Univ. Series.

77. Jeffcoate, T.N.A. Modern Trends in Obstetrics & Gynaecology 2nd Edition. p 238. (Ed.K. Bowes) 1955.

78. Smellie, William. Quoted by Cameron "A Glasgow Manual of Obstetrics" p 30 3rd. Edition E. Arnold & Co.

79. Strachan, G.I., "Textbook of Obstetrics" (1946) p 496. H.K. Lewis

80. Cosgrove, S.A. Amer. Journ. Obst. Gynec. (1936) p 402

81. Donald, Ian. "Practical Obstetric Problems". Ist. Edition. p 335 (Lloyd-Luke).

82. Titus Paul "Management of Obstetric Difficulties" 3rd. Edition. p 552

83. D'Esopo, D.A. Amer. Journ. Obst. & Gynec. (1941) 42 p 937

84. West. Quoted by W. Hunter Journ. Obst. Gynaec. Brit. Emp. (1953) 60 p427

85. Hunter, W. Journ. Obstet. Gynaec. Brit. Emp. (1953) 60 p 427

86. Russell & Soott. Journ. Obst. Gynaec. Brit. Emp. (1953) 60 p 4

87. Bender. Journ. Obst. Gynaec. Brit. Emp. (1953) 60

88. Eastman, N.J. 'Williams Obstetrics' IIth. Edition. p 838

89. de Villiers, d.P. Personal communication

90. LOUW. J.T. PERSONAL COMMUNICATION.

B

Bredentopf. Surgery, Gynec. Obstet. (I934) 59 287.

Burger. Surg. Gynec. Obst. (I934) 59 236.

Bjornson, C. Brit. Med. Journ. (I933) I 3II.

Bill, A.H. Trans. Am. Gynec. Soc. (I93I) 56 I80.

Besold, P. Zentralbl,Gynak. I774.

Beard, R. Journ. Obst. Gynaec. Brit. Emp. 57 33.

Bhadury, P. Journ. Ind. Med. Assoc. (I950) I9 33I.

Brown, F.J. Brit. Med. Journ. (I949) 2 975.

Baxter, J. Journ. Obst. Gynae. Brit. Emp. (I946) 53 2I2.

C

Caldwell, W.A. Amer. Journ. Obstet. & Gynec. (I930) 20 839.

Ibid. Amer. Journ. Obstet. & Gynec. (I933) 26 479.

Ibid. Amer. Journ. Obstet. & Gynec. (I935) 30 763.

Calkins, L.A. Amer. Journ. Obstet. & Gynec. (I93I)
Litzenberg, & Plass. 22 604.

Calkins, L.A. Amer. Journ. Obstet. Gynec. (I939) 37 6I8.

Caldwell, W.A., Amer. Journ. Obstet. Gynec. (I933) 46 268.
Moloy, H.C.

Caldwell, W.A., Amer. Journ. Obstet. Gynec. (I938) 36 928.
Moloy, H.C.,
D'Esopo, D.A.

Calkins, L.A. Amer. Journ. Obstet. Gynec. (I939) 38 993.

Calkins, L.A. Amer. Journ. Obstet. Gynec. (I939) 37 6I8.

Cosgrove, S.A. Amer. Journ. Obstet. Gynec. (I936) 3I 402.

Crotty, J.G. Amer. Journ. Obstet. Gynec. (I935) 30 97.

Calkins, L.A. Obstet. & Gynec. (I953) I 466.

Connell, D.E. Amer. Journ. Obst. Gynec. (I950) 60 246.

Calkins, L.A. Amer. Jcurn. Obst. Gynec. (I947) 53 488.

Calkins, L.A. Amer. Journ. Obst. Gynec. (I944) 48 798.

Ibid Trans. Am. Gynec. Soc. (I944) 68 I2.

Corbet, R.M. Med. Press.(I944) 2I2 278.

D

Danforth, W.C. Amer. Journ. Obstet. & Gynec. (I932) 23 360.

D'Esopo, D.A. Amer. Journ. Obstet. & Gynec. (I94I) 42 937.

Danforth, D.N., Surg. Gynac. & Obst. (I942) 74 I88.

Graham, R.J.,

Ivy, A.C.

Dickson, R.L. Amer. Journ. Obst. (I889) 22 897.

Donglass, L.H. Amer. Journ. Surg. (I937) 35 379.

Danforth, W.C. Amer. Journ. Obst. Gynec. (I934) 28 756.

Dodeck, S.M. J.A.M.C. (I93I) 96 I660.

Dearnly, G. Lancet. (I930) 2 9I9.

Decker,, Amer. Journ. Obst. Gynec. (I95I) 6I 635.

Heaton, C.

E

Eastman, N.J. Obst. & Gynec. Survey (I948) 3 30I.

F

Fink, A. Zentralbl. Gynak. (I952) 74 I828.

Ibid. Zentralbl. Gynak. 73 I720. (Quoted in Excerpta Medica)

G

Gold, E.M. Amer. Journ. Obst. Gynec. (I950) 59 890.

Gibbons, R.A. Lancet. (I934) I II60.

Gauss, C.J. Zentralbl. Gynak. (I95I) 73 5I4.

Gustafson, C.W. Amer. Journ. Obst. & Gynec. (I95I) 6IA 45.

Greene, G.G. Amer. Journ. Obst. Gynec. (I953) 65 6II.

Smith, A.E.M.

H

Heyns, O.S. Journ. Obst. Gynaec. Brit. Emp. (I945) 52 I48.

Hunter, W. Journ. Obst. Gynaec. Brit. Emp. (I943) 50 260.

Hanson. Surg. Gyn. Obst. (I934) 59 I02.

Haynes, D.M. J.A.M.A. (I954) I56 494.

Hunter, W. Journ. Obst. Gynaec. Brit. Emp. (I953) 60 327.

Heelman, L.M. Amer. Journ. Obst. Gynaec. (I952) 63 I223.

Prystowsky, H.

I

Ince, J.H. Journ. Obst. Gynaec. Brit. Emp. (I940) 47 I30.

Young, N.

Ivy, A.C. Obst. Surg. (I939) 69 35I.

(Surg. Gynec. Obst.)

Ivy, A.C. Amer. Journ. Obst. Gynec. (I938) 35 I3I.

J

Jones, J. Journ. Obst. Gynaec. Brit. Emp. (I906) 10 407.

Javert, C.T., Internat. Obstr. Surg. 75 507.

Steele, K.E.

K

Kraatz, H. Zentralbl. Gynak

Quoted in Excerpta Medica.

King, E.L., Amer. Journ. Obst. Gynec. (I95I) 6I 872.

Herring, T.S.,

Dyer, I.,

King, J.A.

Kushner, J.I., Amer. Journ. Obst. Gynec. (I946) 52 II0.

Wahrsinger, P.B.

L

Lloyd, T.S. (Jr.)., Amer. Journ. Obst. Gynec. (I95I) 62 I29.

Ward, S.V.,

Tellers, T.B.

Moir, J. Chassar: Journ. Obstet. & Gynaec. Brit. Emp. (I946) 53 487.

Mast, William. H. Amer. Journ. Obstet. & Gynec. (I933) 26 74.

Miller, D. Brit. Med. Journ. (I928) 2 I83.

Moir, J. Brit. Med. Journ. (I938) 2 555.

Moloy, H.C., D'Esopo, D.A. Amer. Journ. Obst. Gynec. (I936) 32 727.

Moloy, H.C., Amer. Journ. Roentgenol. (I939) 4I 305.

Moloy, H.C. Amer. Journ. Roentgenol. (I939) 4I` 505.

Mengert, W.F., Andrew, W.H., Jennet, R.J. Amer. Journ. Obst. Gynec. (I947) 53 823.

Moloy, H.C. Trans. Amer. Gynec. Soc. 42 (43) 67 I82.

Maxwell, W.H. S. Afr. Med. Journ. (I939) I3 95.

Melliado, G.C. Amer. Journ. Obst. Gynec. (I933) 26 696.

Moir, J. Chassar. Journ. Obst. Gynaec. Brit. Emp. (I932) 39 84.

Mckelvey, J.J., Diefenbach, E.J. Postgrad. Med. (I95I) 9 2II.

Macgregor, T.N. Glascow M.J. (I950) 3I I

MacLennon, H.R. Brit. Med. Journ. (I950) 2 800

Miles, L.M. Amer. Journ. Obst. Gynec. (I948) 55 504.

Murphy, D.P. Amer. Journ. Obstet. Gynec. (I944) 47 52I.

Mikhel, R.M. Surg. Clin. North America. (I945) 25 436. (Symposium)

N

Nicholson, C. Journ. Obstet. & Gynec. Brit. Emp. 45 950.

O

P

Peckham Amer. Journ. Obstet. Gynec. (I932) 24 744.

Potter, M.F. M. Press. (I945) 213 237.

Q

R

Rudolph, L. Amer. Journ. Obst. Gynec. (I93I) 2I 65.
Ivy, A.C.

Rydberg, E. Journ. Obst. Gynaec. Brit. Emp. (I935) 42 600.

Rudolph, L., Amer. Journ. Obst. Gynec. (I933) 25 74.
Ivy, A.C.

S

Scott, R.A. Amer. Journ. Obstet. & Gynec. (1932) 23 400.

Scammon, R.E. "Growth in the Foetal Period" (1929)
& Calkins, L.A. University of Minnesota Press.

Stude, Williams Carl: Surg. Gynec. Obstet. (1933) 50 97.

Steele, K.B., Amer. Journ. Obstet. Gynec (1942) 43 600
Javert, C.T.

Strachan, G.I. Post.Grad. M. J. (1939) 15 263.

T

Torpin, R. Amer. Journ. Obst. Gynec. (1942) 53 78.

Torpin, R., Amer. Journ. Obst. Gynec. 46 268.
Holmes, L.P.

teGroen, L.J. S. A. Med. J. (1935) 9 305.

Thoms, H. Amer. Journ. Obst. Gynec. (1932) 24 50.

Thomas, G.B. Journ. Obst. Gynaec. Brit. Emp. (1945) 52 48.

U

V

Vaux, Norris W: Amer. Journ. Obstet. & Gynec (1932) 20 782.

W

Williams, J.W. "Obstetrics" (1936) 7th edition.

Williams, J.W. Surg. Gyn. Obst. (1909) 8 619.

Williams, J.W. "Obstetrics"
(Ed. W.J. Eastman) Appleton Century Co.

Weinberg, A. J.A.M.A. (I95I) I46 I465.

Williams, B. Brit. Med. Journ. (I953) I 865.

Weinberg, A. Amer. Journ. Surg. (I952) 83 I43.

X

Y

Young, J. Proc. R. Soc. Med. (I9I3) 6 Obst. Gynaec. Sect. I44.